OPERATORS MANUAL AND PARTS CATALOG

FOR

Onan®

ELECTRIC GENERATING PLANTS

LKB

SERIES

ONAN 1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432
A DIVISION OF ONAN CORPORATION

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Important Safety Precautions

Read and observe these safety precautions when using or working on electric generators, engines and related equipment. Also read and follow the literature provided with the equipment.

Proper operation and maintenance are critical to performance and safety. Electricity, fuel, exhaust, moving parts and batteries present hazards that can cause severe personal injury or death.

FUEL, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC

Fire, explosion, and personal injury can result from improper practices.

- Used engine oil, and benzene and lead, found in some gasoline, have been identified by government agencies as causing cancer or reproductive toxicity. When checking, draining or adding fuel or oil, do not ingest, breathe the fumes, or contact gasoline or used oil.
- Do not fill tanks with engine running. Do not smoke around the area. Wipe up oil or fuel spills. Do not leave rags in engine compartment or on equipment. Keep this and surrounding area clean.
- Inspect fuel system before each operation and periodically while running.
- Equip fuel supply with a positive fuel shutoff.
- Do not store or transport equipment with fuel in tank.
- Keep an ABC–rated fire extinguisher available near equipment and adjacent areas for use on all types of fires except alcohol.
- Unless provided with equipment or noted otherwise in installation manual, fuel lines must be copper or steel, secured, free of leaks and separated or shielded from electrical wiring.
- Use approved, non-conductive flexible fuel hose for fuel connections. Do not use copper tubing as a flexible connection. It will work–harden and break.

EXHAUST GAS IS DEADLY

- Engine exhaust contains carbon monoxide (CO), an odorless, invisible, poisonous gas. Learn the symptoms of CO poisoning.
- Never sleep in a vessel, vehicle, or room with a genset or engine running unless the area is equipped with an operating CO detector with an audible alarm.
- Each time the engine or genset is started, or at least every day, thoroughly inspect the exhaust system. Shut down the unit and repair leaks immediately.
- Warning: Engine exhaust is known to the State of California to cause cancer, birth defects and other reproductive harm.

Make sure exhaust is properly ventilated.

- Vessel bilge must have an operating power exhaust.
- Vehicle exhaust system must extend beyond vehicle perimeter and not near windows, doors or vents.
- Do not use engine or genset cooling air to heat an area.
- Do not operate engine/genset in enclosed area without ample fresh air ventilation.
- Expel exhaust away from enclosed, sheltered, or occupied areas.
- Make sure exhaust system components are securely fastened and not warped.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not remove any guards or covers with the equipment running.
- Keep hands, clothing, hair, and jewelry away from moving parts.
- Before performing any maintenance, disconnect battery (negative [–] cable first) to prevent accidental starting.
- Make sure fasteners and joints are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- If adjustments must be made while equipment is running, use extreme caution around hot manifolds and moving parts, etc. Wear safety glasses and protective clothing.

BATTERY GAS IS EXPLOSIVE

- Wear safety glasses and do not smoke while servicing batteries.
- Always disconnect battery negative (–) lead first and reconnect it last. Make sure you connect battery correctly. A direct short across battery terminals can cause an explosion. Do not smoke while servicing batteries. Hydrogen gas given off during charging is explosive.
- Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the area thoroughly.

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can be ignited by equipment operation or cause a diesel engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. **Do not operate diesel equipment where a flammable vapor environment can be created by fuel spill, leak, etc., unless equipped with an automatic safety device to block the air intake and stop the engine.**

HOT COOLANT CAN CAUSE SEVERE PERSONAL INJURY

- Hot coolant is under pressure. Do not loosen the coolant pressure cap while the engine is hot. Let the engine cool before opening the pressure cap.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not service control panel or engine with unit running. High voltages are present. Work that must be done while unit is running should be done only by qualified service personnel.
- Do not connect the generator set to the public utility or to any other electrical power system. Electrocution can occur at a remote site where line or equipment repairs are being made. An approved transfer switch must be used if more than one power source is connected.
- Disconnect starting battery (negative [–] cable first) before removing protective shields or touching electrical equipment. Use insulative mats placed on dry wood platforms. Do not wear jewelry, damp clothing or allow skin surface to be damp when handling electrical equipment.
- Use insulated tools. Do not tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- With transfer switches, keep cabinet closed and locked. Only authorized personnel should have cabinet or operational keys. Due to serious shock hazard from high voltages within cabinet, all service and adjustments must be performed by an electrician or authorized service representative.

If the cabinet must be opened for any reason:

1. Move genset operation switch or Stop/Auto/Handcrank switch (whichever applies) to Stop.
2. Disconnect genset batteries (negative [–] lead first).
3. Remove AC power to automatic transfer switch. If instructions require otherwise, use extreme caution due to shock hazard.

MEDIUM VOLTAGE GENERATOR SETS (601V TO 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training are required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Induced voltage remains even after equipment is disconnected from the power source. Plan maintenance with authorized personnel so equipment can be de-energized and safely grounded.

GENERAL SAFETY PRECAUTIONS

- Do not work on equipment when mentally or physically fatigued or after consuming alcohol or drugs.
- Carefully follow all applicable local, state and federal codes.
- Never step on equipment (as when entering or leaving the engine compartment). It can stress and break unit components, possibly resulting in dangerous operating conditions from leaking fuel, leaking exhaust fumes, etc.
- Keep equipment and area clean. Oil, grease, dirt, or stowed gear can cause fire or damage equipment by restricting airflow.
- Equipment owners and operators are solely responsible for operating equipment safely. Contact your authorized Onan/Cummins dealer or distributor for more information.

KEEP THIS DOCUMENT NEAR EQUIPMENT FOR EASY REFERENCE.

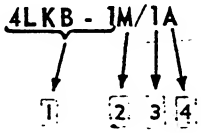
INTRODUCTION

This manual contains all the information necessary for properly servicing LKB electric generating plants. Unless stated otherwise, these instructions apply to all standard plants of the LKB Series. For installation, preparation and operating instructions, refer to Operator's Manual,

Some details of these instructions may not apply to special models having modifications specified by the purchaser. Due to the wide variety of uses for which these plants are suitable, these instructions must be of a general nature. However, by using the instructions and recommendations given in this manual as a general guide, it will be possible to properly service the plant.

Instructions for 60-cycle plants apply also for 50-cycle plants except for current frequency and operating speed. The engine end is designated as the *front end* of the plant. *Left side* and *right side* of the plant are determined by viewing from the front end.

How to interpret MODEL and SPEC. NO.



1. Factory code for general identification.
2. Specific Type:
   M-MANUAL Manually cranked. For permanent or portable installations.

   R-REMOTE. Electric starting. For permanent installation, can be connected to optional accessory equipment for remote or automatic control of starting and stopping.
3. Factory code for optional equipment.
4. Specification (Spec.) letter (advances when factory makes production modifications).

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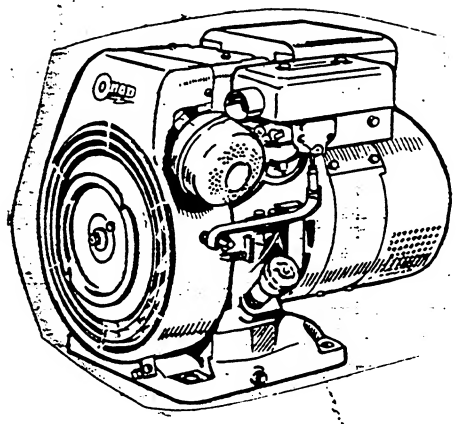


DESCRIPTION

GENERAL

LKB generating plants are a complete electric power plant, consisting of an internal combustion engine, and a self excited electric generator, directly connected to the engine. Controls and accessories suitable for normal installation and according to the particular model are supplied.

Each generating plant is given an actual running test at the factory and is carefully checked under various electrical load conditions before shipment, to assure that it is free of any defect and that it meets all performance requirements.

ENGINE

- TYPE: Vertical 1-cylinder, L-head, 4-stroke cycle.
- BORE: 3-1/4"
- STROKE: 3"
- DISPLACEMENT: 24.9 cubic inches
- HORSEPOWER: 8.2 bhp @ 3600 rpm
- COMPRESSION RATIO: 7 to 1
- CYLINDER & CRANKCASE: Integral, cast iron.
- MAIN BEARINGS: Precision sleeve type, babbitt faced, steel backed
- CAMSHAFT BEARINGS: Precision sleeve type, babbitt steel backed
- PISTON: 3-ring, aluminum alloy, full floating type piston pin
- VALVES: Intake – carbon steel
  Exhaust – austenitic steel with hard chrome cobalt alloy facing
  Hardchrome – cobalt alloy seat insert, replaceable
- CONNECTING RODS: Forged – Precision Bearing
- LUBRICATION: Gear Pump
- COOLING: Air, pressure flow, volume 760 cfm
- SPEED CONTROL: Internal centrifugal flyball governor, external adjustments
- IGNITION: Flywheel magneto, Shielded system
- FUEL: Gasoline (gas optional)

CONTROLS

AC Manual Plants: These plants are started by manually cranking with a pull rope (carburetors are manually choked). Electrical load is connected to the plant by plugging into receptacles mounted on the plant. Plants are stopped by pushing a stop button on the plant blower housing. These plants can not be connected to batteries for electric starting.

GENERATOR

- TYPE: Revolving armature, 2 pole, rectifier excitation, inherently regulated, Drip-proof design. Permanently aligned to the engine.
- RATING: Capacity 4000 watts, AC, at unity power factor, 60-cycle.
- FREQUENCY REGULATION: 3 cycles (5%) no load to the rated capacity 60 cycle operation
- VOLTAGE REGULATION: Plus or minus 6% no load to the rated capacity 60 cycle operation
- COOLING: Direct drive centrifugal blower. Air required 120 cfm

SPECIFICATIONS

Nominal dimension of plant (inches)	
Height	21
Width	19
Length	28-1/4
Number cylinders	1
Displacement (cubic inch)	25
Cylinder bore	3-1/4
Piston stroke	3
RPM (for 60-cycle)	3600
RPM (for 50-cycle)	3000
Compression ratio	7:1
Ignition (type)	
Flywheel magneto	Yes
Starting by pull rope (recoil) only	Yes
Ventilation Required (cfm 3600 rpm)	
Engine	600
Generator	125
Combustion	30
Output rated at unity factor load	All
Rating (Output in watts)	
50-cycle AC	3,500
60-cycle AC	4,000
AC voltage regulation in ± %	6
AC frequency regulation in %	5
Revolving armature type generator	Yes
120/240-volt single-phase model reconnectible	No

TABLE OF CLEARANCES

CLEARANCES (room temperature 70° F)

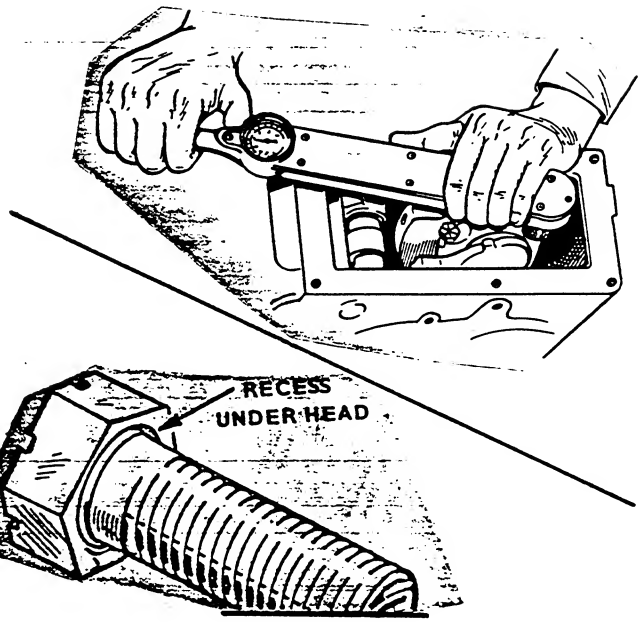
	Minimum	Maximum
Intake Valve Tappet Clearance at 70° F.	0.010	0.012
Exhaust Valve Tappet Clearance at 70° F.	0.010	0.012
Intake Valve Stem Clearance in Guide	0.001"	0.0025"
Exhaust Valve Stem Clearance in Guide	0.0025"	0.004"
Valve Seat Width	1/32"	3/64"
Valve FACE Angle	44°	
Valve SEAT Angle	45°	
Valve Interference Angle	1°	
Crankshaft Main Bearing Clearance	0.002"	0.003"
Crankshaft End Play	0.006"	0.012"
Camshaft Bearing Clearance	0.0015"	0.0030"
Camshaft End Play	0.003"	
Connecting Rod Bearing Clearance		
(Alum. Rod)	0.002"	0.003"
Connecting Rod End Play	0.013"	0.038"
Timing Gear Backlash	0.002"	0.003"
Piston Clearance in Cylinder, Conformatic		
Type (at bottom of skirt)		
Interference	0.0005"	
Clearance		0.0015"
Piston Pin Clearance in Piston at 70° F.	Thumb Push Fit	
Piston Pin Clearance in Rod at 70° F.	0.0001"	0.0007"
Piston Ring Gap in Cylinder	0.010"	0.023"
Breaker Point Gap at Full Separation	0.020"	
Spark Plug Gap – For Gaseous Fuel	0.018"	
Spark Plug Gap – For Gasoline Fuel	0.025"	
Crankshaft Main Bearing Journal – Std. Size	1.9995"	2.000"
Crankshaft Rod Bearing Journal – Std. Size	1.6255"	1.6260"
Cylinder Bore – Standard Size	3.249"	3.250"
Magneto Pole Shoe Air Gap	0.010"	0.015"

TABLE OF TORQUES

The assembly torques given here will assure proper tightness without danger of stripping threads or fracturing the surrounding material. It is very important to uniformly tighten bolts, nuts or studs, such as those in the cylinder head to evenly distribute the stress. If a torque wrench is not available, estimate the degree of tightness necessary. Use reasonable force only with a wrench of normal length.

Always clean and lubricate threads with Tight Seal or any good thread lubricant.

Specially designed place bolts do not require a lock washer or gasket. Do not attempt to use a lock washer with these bolts, it will defeat their purpose. To avoid breaking these bolts, tighten within the limits specified. Under-torqueing may also cause them to break.



TORQUE (LB. FT.)	
Cylinder Head Capscrew	27 to 29
Rear Bearing Plate Nuts	20 to 25
Connecting Rod Bolts	24 to 28
Flywheel Capscrew	40 to 45
Generator Thru-Stud and Nut	45 to 50
Gearcase Cover	15 to 20
Oil Base Mounting Screws	43 to 48
Spark Plug	25 to 30
Other 5/16 inch Cylinder Block Studs and Nuts	10 to 12

MAINTENANCE SCHEDULE

Use this factory recommended maintenance schedule to serve as a guide to get long and efficient plant life. Neglecting routine maintenance can result in failure or permanent damage to the plant. This schedule is based on favorable operating conditions. It may be necessary to adjust the maintenance intervals to fit other conditions such as extremely dusty or dirty conditions, etc.

MAINTENANCE ITEMS	OPERATIONAL HOURS			
	200	500	1000	2500
Check Breaker Points	x			
Clean Commutator and Collector Rings (Do not remove Film)	x1			
Check Brushes	x2			
Remove Carbon & Lead		x		
Check Valve Clearance		x		
Clean Carburetor		x		
Clean Generator			x	
Remove & Clean Oil Base			x	
Grind Valves			x	
General Overhaul				x

x2 - Replace brushes when worn to 5/8" or less.

TROUBLE SHOOTING CHART

POSSIBLE CAUSE	REMEDY
ENGINE CRANKS TOO STIFFLY	
Too heavy oil in crankcase.	Drain, refill with lighter oil.
Engine stuck.	Disassemble and repair.
ENGINE WILL NOT START WHEN CRANKED	
Faulty ignition.	Clean, adjust, or replace breaker points, plug, condenser, etc., or retime magneto.
Lack of fuel or faulty carburetion.	Refill the tank. Check the fuel system. Clean, adjust or replace parts necessary.
Clogged fuel screen.	Clean
Cylinder flooded.	Crank few times with spark plug removed.
Poor fuel.	Drain, refill with good fuel.
Poor compression.	Tighten cylinder head and spark plug. If still not corrected, grind the valves, replace piston rings if necessary.
Wrong Timing.	Reset breaker points or retime magneto.
ENGINE STOPS UNEXPECTEDLY	
Fuel tank empty.	Refill.
Defective ignition.	Check the ignition system Repair or replace parts necessary.
SHARP METALLIC THUD, ESPECIALLY WHEN COLD ENGINE FIRST STARTED	
Low oil supply.	Add oil.
Oil badly diluted.	Change oil.

POSSIBLE CAUSE	REMEDY
EXCESSIVE OIL CONSUMPTION, LIGHT BLUE SMOKY EXHAUST	
Poor compression, usually due to worn piston, rings or cylinder.	Refinish cylinder. Replace piston and rings.
Oil leaks from oil base or connections. This does not cause smoky exhaust.	Replace gaskets. Tighten screws and connections. Check breather valve.
Oil too light or diluted.	Drain, refill with correct oil.
Worn engine.	Repair as necessary.
Worn intake valve guide or valve stem.	Replace.
Engine misfiring.	Refer to symptoms of engine misfiring.
Faulty ignition.	Clean, adjust or replace breaker points, plug, condenser, etc., or retime magneto.
Too much oil.	Drain excess oil.
BLACK, SMOKY EXHAUST, EXCESSIVE FUEL CONSUMPTION, FOULING OF SPARK PLUG WITH BLACK SOOT, POSSIBLE LACK OF POWER UNDER HEAVY LOAD	
Fuel mixture too rich.	Adjust carburetor or choke. Install needed carburetor parts.
Choke not open.	See that choke opens properly.
Dirty air cleaner.	Clean.
Excessive crankcase pressure.	Clean breather valve.
TAPPING SOUND	
Tappet clearance too great.	Adjust or replace tappets.
Broken valve spring.	Install new spring.

POSSIBLE CAUSE	REMEDY
LIGHT POUNDING KNOCK	
Loose connecting rod bearing.	Adjust or replace.
Low oil supply.	Add oil.
Oil badly diluted.	Change oil
DULL METALLIC THUD. IF NOT BAD, MAY DISAPPEAR AFTER FEW MINUTES OPERATION. IF BAD, INCREASES WITH LOAD	
Loose crankshaft bearing.	Replace unless one of the next two remedies permanently corrects the trouble.
PINGING SOUND WHEN ENGINE IS SUDDENLY OR HEAVILY LOADED	
Carbon in cylinder.	Remove carbon.
Spark too early.	Adjust breaker points or retime magneto.
Wrong spark plug.	Install correct spark plug.
Spark plug burned or carboned.	Install new plug.
Valves hot.	Adjust tappet clearance.
Fuel stale or low octane.	Use good fresh fuel.
Lean fuel mixture.	Clean and adjust carburetor.
Engine hot.	Check air circulation.
ENGINE MISFIRES AT LIGHT LOAD	
Spark plug gap too narrow.	Adjust to correct gap.
Intake air leak.	Tighten or replace gaskets.
Faulty ignition.	Clean, adjust or replace breaker points, plug, condenser, etc., or retime ignition.
Low compression.	Tighten cylinder head and spark plug. If still not corrected, grind valves. Replace piston rings, if necessary.

POSSIBLE CAUSE	REMEDY
ENGINE MISFIRES AT HEAVY LOAD	
Spark plug gap too wide.	Adjust gap.
Faulty ignition.	Clean, adjust or replace breaker points, plug, condenser, etc., or retime magneto.
Clogged carburetor.	Clean jet.
Clogged fuel screen.	Clean.
ENGINE BACKFIRES AT CARBURETOR	
Lean fuel mixture.	Clean or adjust carburetor.
Clogged fuel screen.	Clean screen.
Poor fuel.	Refill with good, fresh fuel.
Spark too late.	Adjust breaker points or retime magneto.
Intake valve leaking.	Grind or replace.
HOLLOW CLICKING SOUND WITH COOL ENGINE UNDER LOAD	
Loose piston.	If noise only slight and dissapears when engine warms up, no immediate attention needed. Otherwise replace worn parts.
ENGINE RUNS BUT VOLTAGE DOES NOT BUILD UP	
Open circuit, short circuit.	See Generator Repair, Replace part necessary.
Residual magnetism lost	Magnetize the field.
Direct short on AC.	Remove AC load.
VOLTAGE UNSTEADY BUT ENGINE NOT MISFIRING	
Speed too low.	Adjust governor to correct speed.
Loose connections.	Tighten connections.
Fluctuating load.	Correct any abnormal load condition causing trouble.

POSSIBLE CAUSE	REMEDY
GENERATOR OVER-HEATING	
Over-loaded.	Reduce load.
EXCESSIVE ARCING OF BRUSHES	
Brushes not seating properly.	Sand to a good seat.
Open circuit in armature.	Replace.
VOLTAGE LOW AT FAR END OF LINE BUT NORMAL NEAR POWER PLANT	
Too small line wire for load and distance.	Install larger or extra wires or reduce load.
ELECTRIC MOTOR RUNS TOO SLOWLY AND OVER-HEATS AT FAR END OF LINE BUT OK IF USED NEAR POWER UNIT	
Too small line wire for load and distance.	Install larger or extra wires or reduce load.
VOLTAGE DROPS UNDER HEAVY LOAD	
Engine lacks power.	See remedies for engine misfires under heavy load.
Poor compression.	Tighten cylinder load and spark plug. If still not connected, grind the valves. Replace piston rings, if necessary.
Faulty carburetion.	Check the fuel system. Clean, adjust or replace parts necessary.
Dirty air cleaner.	Clean.
Choke partially closed	See that it opens wide.
Carbon in cylinders.	Remove carbon.
Restricted exhaust line.	Clean or increase the size.
Governor out of adjustment.	Re-adjust governor sensitivity screw.

ENGINE MAINTENANCE AND REPAIR

COOLING AIR

Cooling air is taken in at the blower housing and directed by cylinder housings and baffles to all parts of the engine. As it flows over the fins, the cooling air absorbs and carries away heat. If cooling air does not reach a part of the engine or if a fin is broken so heat cannot be transferred, that part of the engine will overheat. If severe enough, overheating may cause cylinder scoring. To guard against damage to the engine, check the engine cooling system. Make sure that there is a sufficient supply of air, that the housings and baffles are correctly installed and that all holes are plugged or covered.

AIR FILTER SYSTEM

Proper maintenance of the air cleaner is extremely important. Dirt entering the engine through improperly installed, improperly serviced or inadequate elements wears out more engines than does long hours of operation. A small amount of dirt will wear out a set of piston rings in a few hours. Operating with a clogged element causes a richer fuel mixture which can lead to formation of harmful sludge deposits.

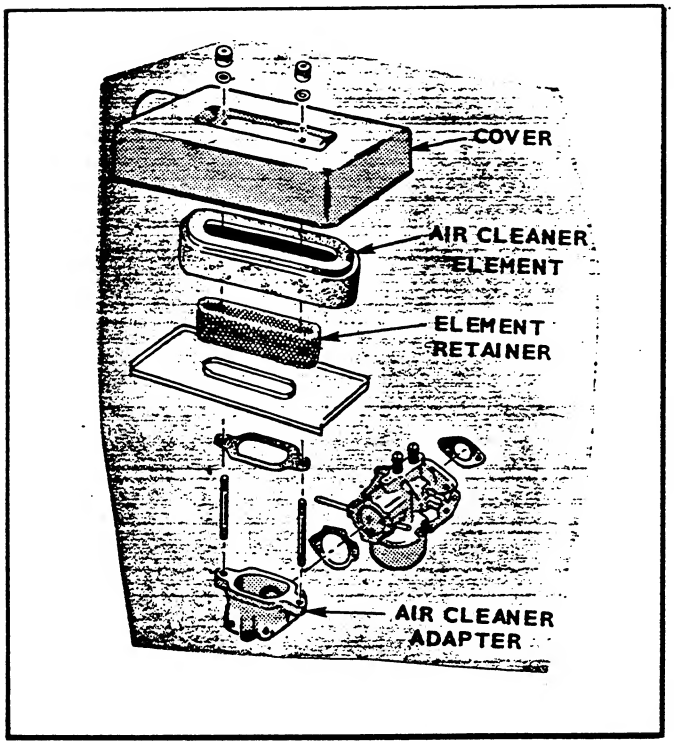


FIG. 1 - AIR CLEANER

To service the air cleaner :

1. Remove cover, element, retainer and pan.

NOTE: *Always cover air cleaner adapter when air cleaner is removed for servicing.*

2. Thoroughly clean cover, retainer and pan in clean solvent. Wash the element in gasoline. Then dip it in clean fresh crankcase grade oil and squeeze as dry as possible. Replace element if damaged.
3. Inspect air cleaner adapter and gasket. Replace if damaged, cracked or badly grooved.
4. Re-install all parts in the same manner as previously installed.
5. Check to make sure air cleaner is properly installed so that no unfiltered air can enter the carburetor.

FUEL SYSTEM

Service difficulties with fuel systems usually are caused by improper carburetor adjustments or dirt, gum, or varnish in the components. A small piece of foreign matter in a jet may cause hard starting and poor operation. Dirty gasoline may cause the jets to wear larger, resulting in excessive gasoline consumption. Improper adjustment can cause overheating, fouled spark plug, excessive valve wear and other problems.

It will be necessary to disassemble the carburetor to clean it thoroughly. The frequency of cleaning will depend on use and operating conditions.

All parts should be cleaned in a solvent. Gum or varnish is easily removed with an alcohol or acetone solvent. Be sure any carbon deposits are removed from the bore, especially where the throttle plate seats in the casting. Blow out all passages with compressed air. Replace all worn or damaged parts. *Always use new gaskets.* Carburetor repair kits are available. They include a gasket kit, float lever pin, fuel inlet valve, throttle shaft seal and retainer.

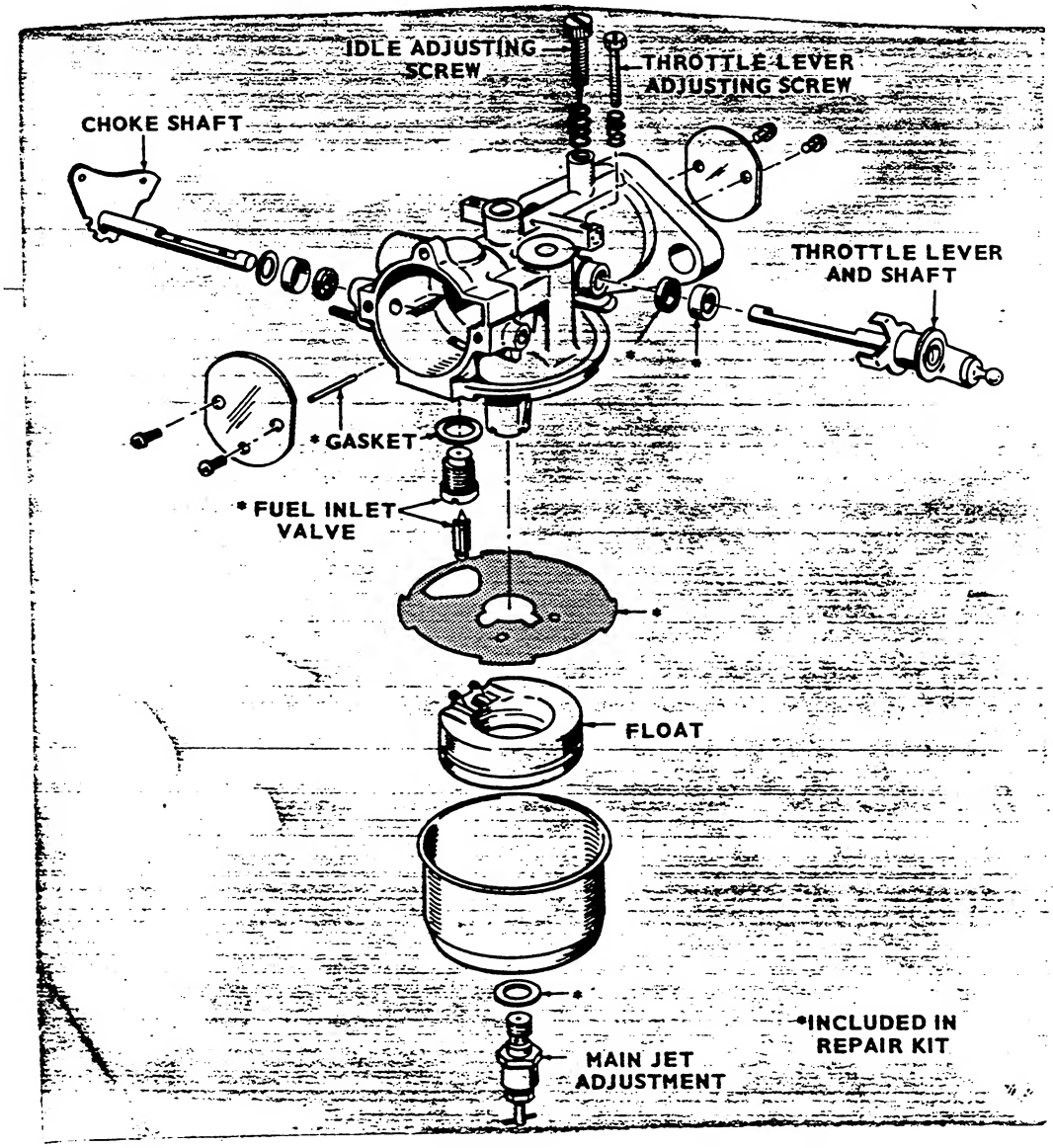


FIG.2 - CARBURETOR

The carburetor is a side (horizontal) draft type and has two adjusting needles. See Fig. 3 for location of needles. The main jet adjustment affects operation under heavy load conditions. Idle adjustment affects operation at light or no load. Turning a needle inward, gives a leaner fuel mixture for that jet.

Full-load and no-load operating conditions are necessary when making carburetor adjustments. To obtain a full rated load condition, connect an AC load equal to the watt or ampere rating shown on the nameplate.

To obtain a no-load condition, disconnect all AC load, leaving starting batteries (where used) connected and with governor properly adjusted.

Make the idle adjustment with no AC load connected to the generator. Use a frequency meter connected to the generator output (each cycle per second equals 60 rpm engine speed). Slowly turn the idle adjusting needle inward (clockwise) until the generator frequency (or engine speed) drops slightly below normal. Then turn the needle out until the frequency (or speed) returns to normal.

To set the main jet adjustment, apply a full electrical load to the generator. Carefully turn the main adjusting screw inward (clockwise) until the generator frequency (or engine speed) drops slightly below normal. Then turn the needle out until the frequency (or speed) returns to normal. If there is a tendency to hunt (alternately increase and decrease speed) at any load, turn the adjusting needle out until the hunt is corrected. Do not turn the needle out more than 1/2 turn beyond the point where maximum generator output is obtained. Continuous unstable operation may be due to improper governor adjustment.

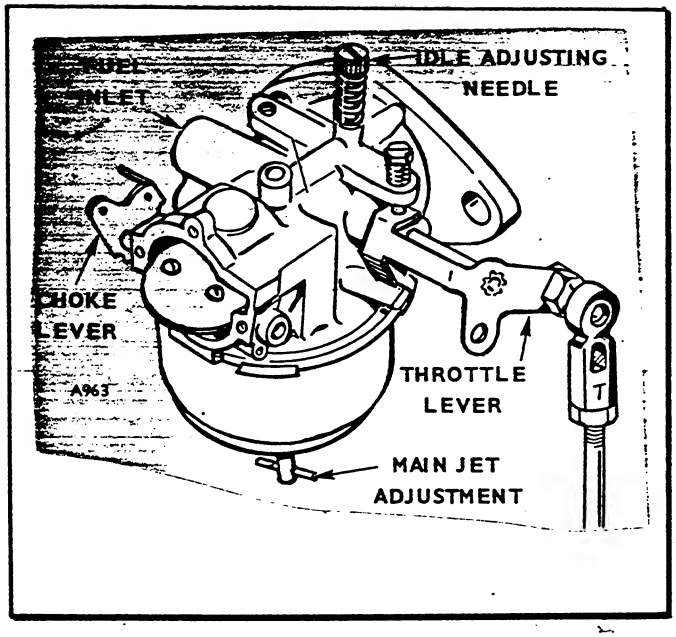


FIG.3 - CARBURETOR ADJUSTMENT

6. Install idle fuel adjustment needle. Back out approximately 1-1/2 turns after seating lightly against jet. CAUTION: DO NOT USE FORCE ON ADJUSTMENT NEEDLES.

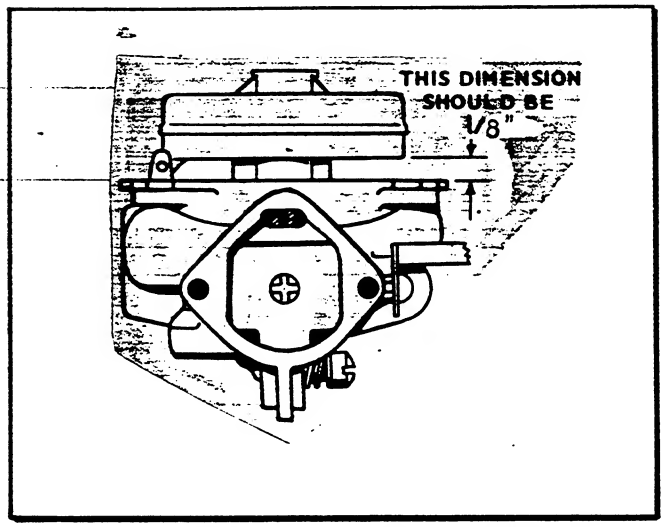


FIG.4 - CARBURETOR FLOAT ADJUSTMENT

The throttle idle stop screw should be adjusted to clear the throttle shaft stop by 1/32" when the plant is operating at desired speed and no-load condition. This setting helps prevent hunting during changes in load.

CARBURETOR RECONDITIONING

1. Remove carburetor from engine.
2. Remove bowl nut, gasket and bowl.
3. Remove float pin, float, needle and needle seat. Check float for dents, leaks and wear on float lip or in float pin holes.
4. Remove bowl ring gasket.
5. Remove idle fuel adjusting needle, main fuel adjusting needle and springs.
6. *Do not* remove choke and throttle plates and shafts. If these parts are worn, replace carburetor assembly.

ASSEMBLY OF CARBURETOR

1. Install needle seat, needle, float and float pin.
2. Set float level. With carburetor casting inverted and float resting lightly against needle in its seat, there should be 1/8", plus or minus 1/32 of an inch clearance between machined surface of casting and free end of float (side opposite needle seat). See Fig. 4.
3. Adjust by bending lip of float with small screwdriver.
4. Install new bowl ring gasket, new bowl nut gasket (when required) and bowl nut. Tighten securely after making sure bowl is centered on gasket.
5. Install main fuel adjustment needle. Turn in until needle seats in nozzle and back out two turns.

FUEL PUMP

The fuel pump is mechanically operated off a cam on the camshaft. The fuel pump lever rides on the cam and transmits this action to a diaphragm within the pump body.

A repair kit is available for reconditioning the pump. The parts included are noted in the drawing (Fig. 5).

FUEL PUMP RECONDITIONING

1. Remove fuel lines and mounting screws holding pump to engine.
2. With a file, make an indicating mark across a point at the union of fuel pump body and cover. This is a positive marking to assure proper reassembly. Remove assembly screws and remove upper pump body.
3. Turn pump body over and remove valve plate screw and washer. Remove valve retainer, valves, valve springs and valve gasket, *noting their position.* Discard valve springs, valves and valve retainer gasket.
4. Clean pump body thoroughly with solvent and a fine wire brush.
5. Holding pump cover with diaphragm surface up, place new valve gasket into the cavity. Now assemble the valve spring and valves into the cavity and reassemble valve retainer and lock in position by inserting and tightening fuel pump valve retainer screw.
6. Place pump body assembly in a clean place and rebuild the lower diaphragm section.

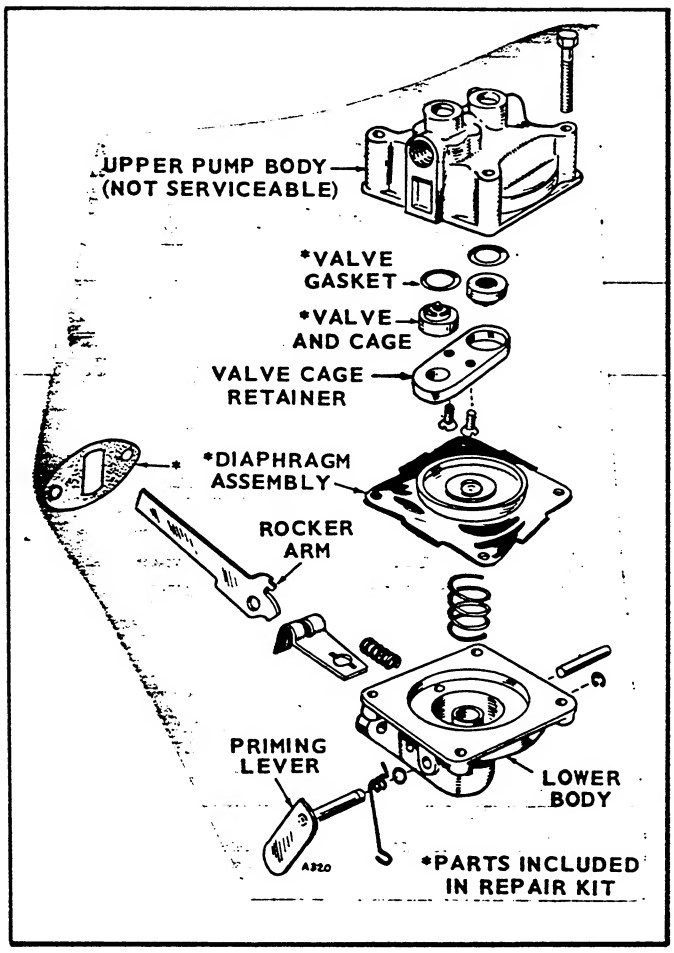


FIG.5 - FUEL PUMP

7. Holding mounting bracket, press down on the diaphragm to compress spring under it, then turn bracket 90° to unhook diaphragm so it can be removed.
8. Clean mounting bracket with a solvent and a fine wire brush.
9. Replace the diaphragm operating spring, stand new spring in casting, position diaphragm and press down on diaphragm to compress spring and turn 90° to reconnect diaphragm.
10. Hold bracket, then place the pump cover on it (make sure that indicating marks are in line) and insert the four screws. DO NOT TIGHTEN. With the hand on the mounting bracket only, push the the pump lever to the limit of its travel and hold in this position while tightening the four screws. This is important to prevent stretching the diaphragm.
11. Mount the fuel pump on engine, using new mounting gaskets. Connect the fuel lines.

GOVERNOR

The governor controls the speed of the engine which in turn controls the voltage on both AC and DC electric generating plants. It also controls the frequency of the current on AC plants. It is important that the governor is kept properly adjusted to hold the engine speed as constant as possible, even throughout a variation of load conditions.

A general description of the operation of the governor may be of help in determining the cause of trouble if governor operation is erratic.

The engine is equipped with a centrifugal, flyball, mechanical type governor. The governor gear and flyball mechanism is mounted within the gear cover and driven off a gear on the camshaft.

Centrifugal force causes the weights to move outward as the engine speed increases. This force causes the governor cup to move outward also, which, in turn moves the governor shaft yoke causing the governor shaft to rotate. One end of the shaft extends through the gear cover. Through external linkage, the action of the governor shaft is transmitted to the throttle valve in the carburetor.

Tension of the governor spring pulls the cup and weights inward as the speed decreases. When the engine is not running, the tension or the governor spring should hold the throttle valve in open position.

When a normal load is applied and engine speed tends to decrease, the resulting rotation of the cross shaft acts against the governor spring to supply more fuel and restores engine speed. When the governor is properly adjusted this action takes place so rapidly that a reduction in speed is hardly noticed. As speed again reaches governed setting, the shaft rotates to either open or close the throttle valve to maintain speed at a relatively constant level. Regulation is accurate within 5%.

GOV. ARM & LINKAGE

Before any governor adjustments are made, be sure the rest of the engine is in proper operating condition (fuel system, ignition system etc.). Frequently, governor problems are caused by a poorly running engine.

Binding in the bearings of the shaft, in the ball joint or in the carburetor throttle assembly will cause the governor to act slowly and regulation will be poor. Excessive looseness in the mechanism will cause erratic governor action or an alternate increase and decrease in speed (hunting). Work the governor arm back and forth several times by hand while the plant is at idle. If either of the foregoing conditions exist, determine at which point the trouble lies and adjust or replace the part as required.

The linkage and the position of the governor arm must synchronize the travel of the governor and the throttle plate so that the governor is in the wide open position when the throttle plate is in its wide open position and the governor is at its closed position when the throttle plate is at its closed position.

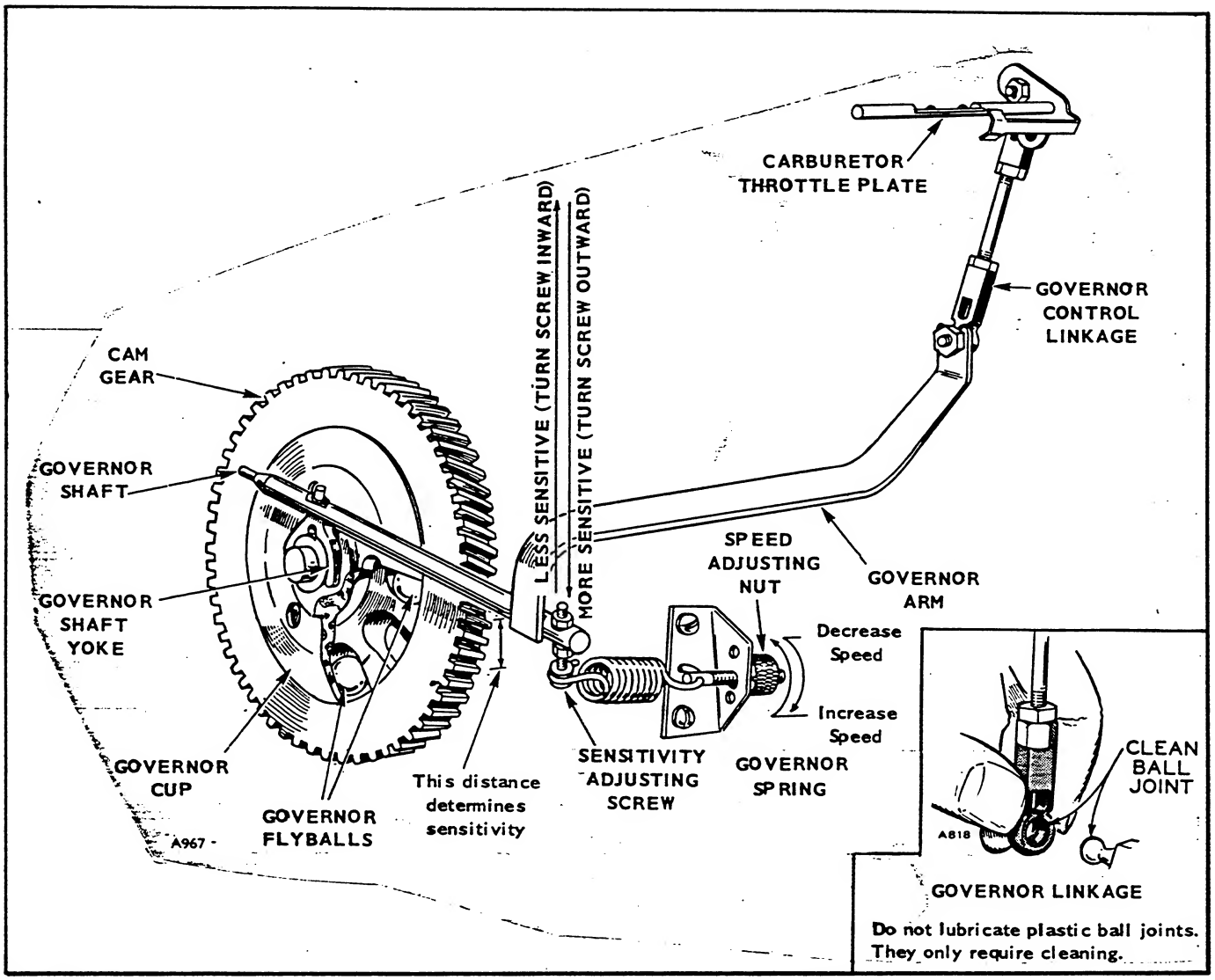


FIG.6 - GOVERNOR ASSEMBLY

At wide open position, the lever on the throttle shaft should just touch the carburetor body or clear it by no more than 1/32". This setting can be obtained by changing the length of the connecting linkage as necessary by turning the ball joints on the threads of the link.

SPEED ADJUSTMENT

The setting of the speed adjusting screw (Fig. 6) determines the speed at which the engine operates. Connect a voltmeter or frequency meter (or use a tachometer if these are not available) to the output of the generator. Start the engine and allow it to warm up. Set the engine speed within the limits given in the table below.

	NOMINAL OUT PUT	MAXIMUM ALLOWABLE	MINIMUM ALLOWABLE	PREFERRED NO LOAD TO FULL LOAD	MAX. SPREAD NO LOAD TO FULL LOAD	PREFERRED SPREAD NO LOAD TO FULL LOAD
FREQUENCY (CPS)	60	64	57	61-59	3	1.5
VOLTAGE (V)	120 120/240	126 252	110 220	125-111 250-220		
SPEED (RPM)	3600	3840	3420	3660-3540	180	90

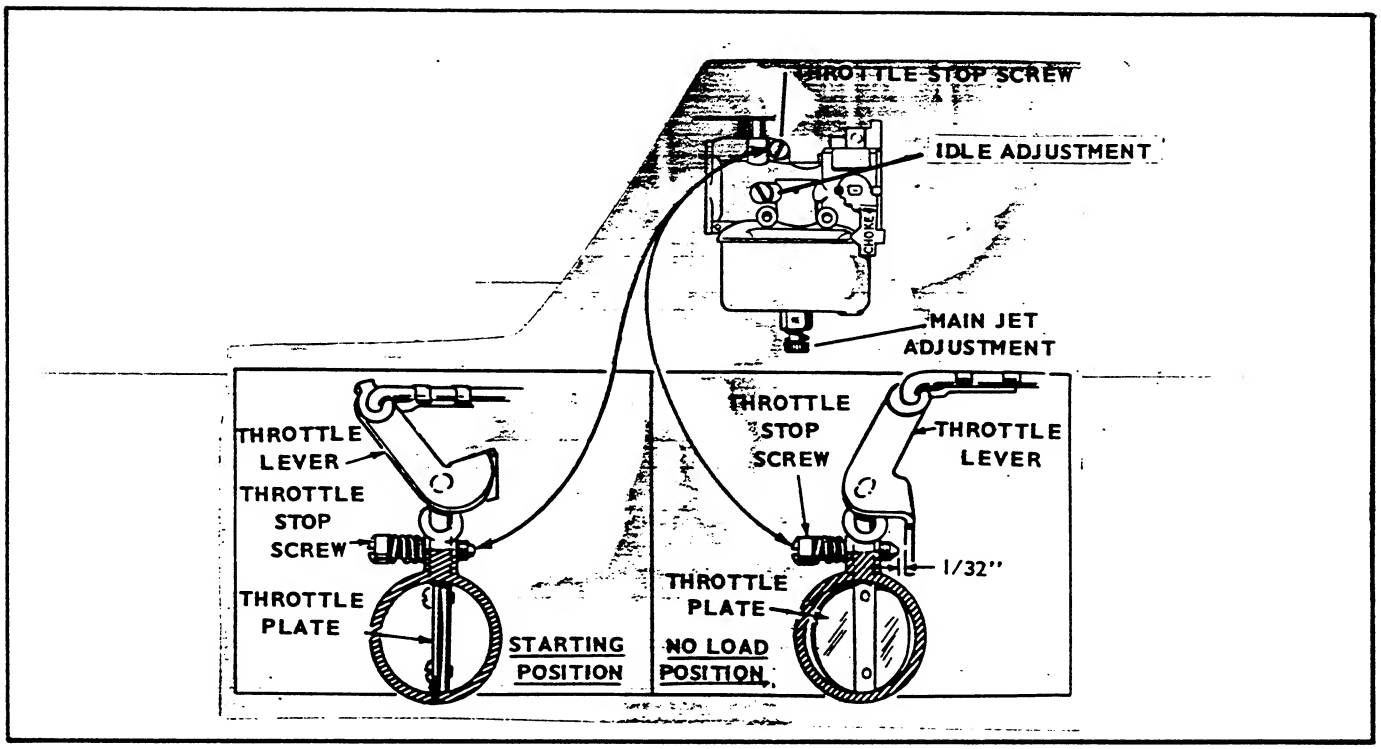


FIG.7 - THROTTLE STOP ADJUSTMENT

SENSITIVITY ADJUSTMENT

The correct sensitivity adjustment gives the closest regulation without causing a hunting condition. If the voltage spread between no-load and full-load conditions is too great, move the end of the governor speed spring closer to the governor shaft. Test the governor action at various load conditions. If voltage regulation is good but there is a tendency toward hunting at times, the sensitivity adjustment is too close or sharp and the sensitivity stud must be turned outward slightly. Any change in the sensitivity adjustment will require a speed re-adjustment.

GOVERNOR SPRING

Due to the fact that springs become fatigued and lose their calibrated tension from long usage, it is sometimes necessary to replace the governor spring to get proper regulation. It is difficult to determine whether or not a spring is fatigued. Usually, if all other adjustments have been properly made and the regulation is still eratic, replacing the governor spring and resetting the sensitivity and speed adjusting screws will correct the trouble.

IGNITION SYSTEM

In order to receive satisfactory performance of the ignition system all components must be in good condition and the spark must be properly timed. Hard starting, low power and erratic operation can often be caused by faulty ignition. If poor ignition is suspected, the first thing to do is to determine if the ignition system is actually at fault. A simple operational test will determine this.

Remove the high tension lead from the spark plug and hold the end terminal approximately 3/16" from a clean metal part of the engine. Crank the engine fast enough to produce a spark. If a sharp, snappy spark occurs, the trouble apparently is not in the coil, condenser, or breaker points although it could be in the spark plug. If there is no spark or one that is weak or yellowish in color, ignition trouble is indicated.

High Tension Lead: Inspect ignition lead for cracks or breaks in the insulation that may weaken the current before it reaches a plug. A ground wire touching metal at some point may make operation unsatisfactory.

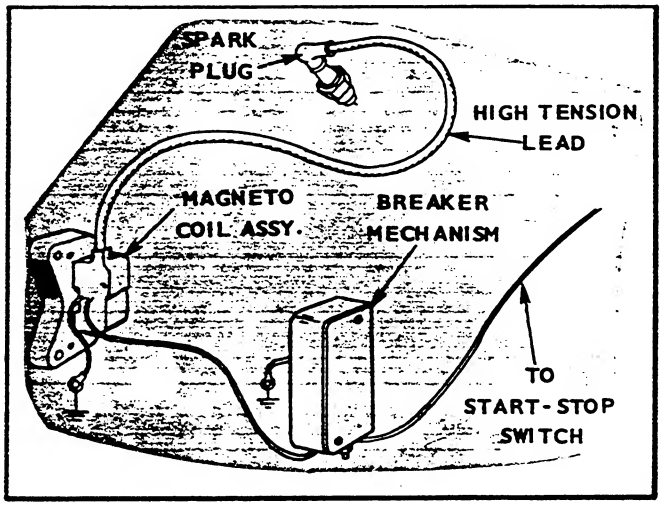


FIG.8 - IGNITION SYSTEM

Spark Plug: Engine misfire or generally poor operation is often caused by a spark plug in poor condition or with the wrong gap setting. Remove the spark plug and carefully check for the following conditions:

- Porcelain insulator cracked or coated with oil
- Electrodes burned or worn away.
- Wrong gap setting.

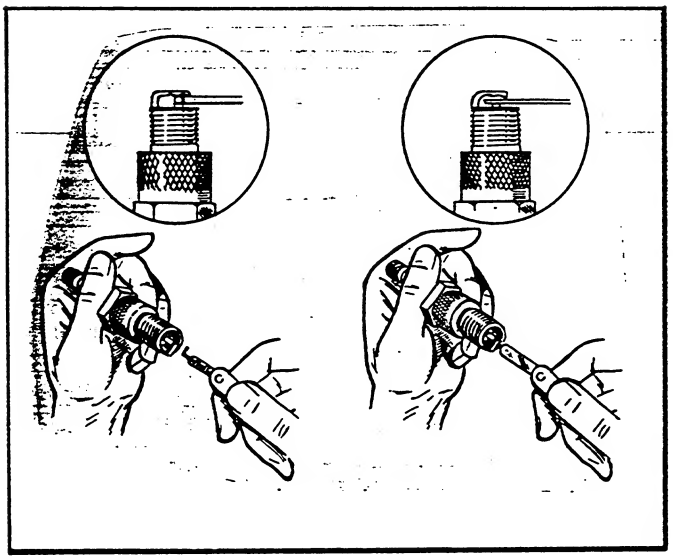


FIG.9 - SPARK PLUG SETTING

If the porcelain insulator is cracked or broken or if the electrodes are badly worn or burned replace the spark plug with a new one.

If not, it can probably be restored to good operating condition by the following steps:

1. Degrease wet or oily plug and dry thoroughly.
2. File center electrode to a flat surface.
3. Adjust gap to .025" for gasoline or .018" for gaseous fuel. Use a round wire gauge for more accurate measurement.
4. Install plug. Tighten to torque value of 25-30 ft. pounds.

Breaker Points: The condition and adjustment of the breaker points greatly affect the performance of the engine. If points are burned or badly oxidized, little or no current will pass. As a result, the engine may not operate at all or, if it does run, it is likely to miss, particularly at full throttle.

Always replace badly burned or pitted breaker points. If only slightly pitted or burned, the points can be dressed down with a file or fine stone. This will help temporarily but points should be replaced at first opportunity. If points are oxidized, rub a piece of coarse cloth across the surface. Dirty or oily points can be cleaned with a cloth but be sure no particles of lint are left between surfaces.

Measure the gap with a thickness gauge and set at .020". To set the gap, crank the engine to fully open the breaker points (1/4 turn after top center). Loosen and move stationary contact to correct the gap at full separation. The mating surfaces of breaker points must make contact evenly. Point alignment is extremely important to proper engine operation and point life.

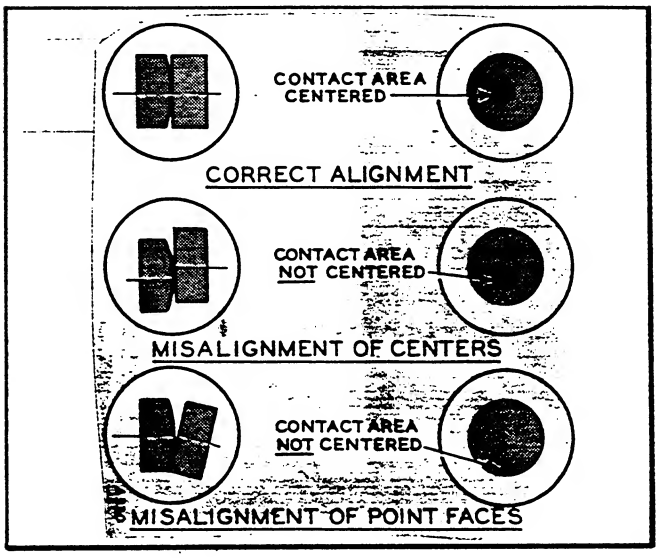


FIG. 10 - POINT ALIGNMENT

Adjustment of the breaker points affects the time that contacts are opened and closed. Timing of the spark plug firing, which occurs when the breaker points separate, is critical to best engine performance. The spark must fire the fuel mixture at the proper split second when the piston is at the proper location in the cylinder to get the most power from the fuel charge. Set the ignition timing as follows:

1. Remove breaker box cover.
2. Crank the engine over slowly by hand in the direction of crankshaft rotation until the witness mark on the flywheel and the "TC" mark on the gear cover are exactly in line ON THE COMPRESSION STROKE (Fig. 11).
3. Adjust the ignition breaker point gap width to .020 inch at full separation.
4. Turn the flywheel to the left, against crankshaft rotation, until the mark is about two inches past the 25° mark on the gear cover.
5. Turn the flywheel slowly to the right and note whether the ignition points just separate when the mark on the flywheel aligns with the 19° mark on the gear cover (engine must be on the compression stroke). If marks align as the points break, timing is correct. If not, loosen the breaker box mounting screws and shift the whole breaker box assembly slightly upward to retard the timing (points breaking too soon), or slightly downward to advance the timing (points not breaking soon enough). Tighten the breaker box mounting screws securely after making an adjustment.

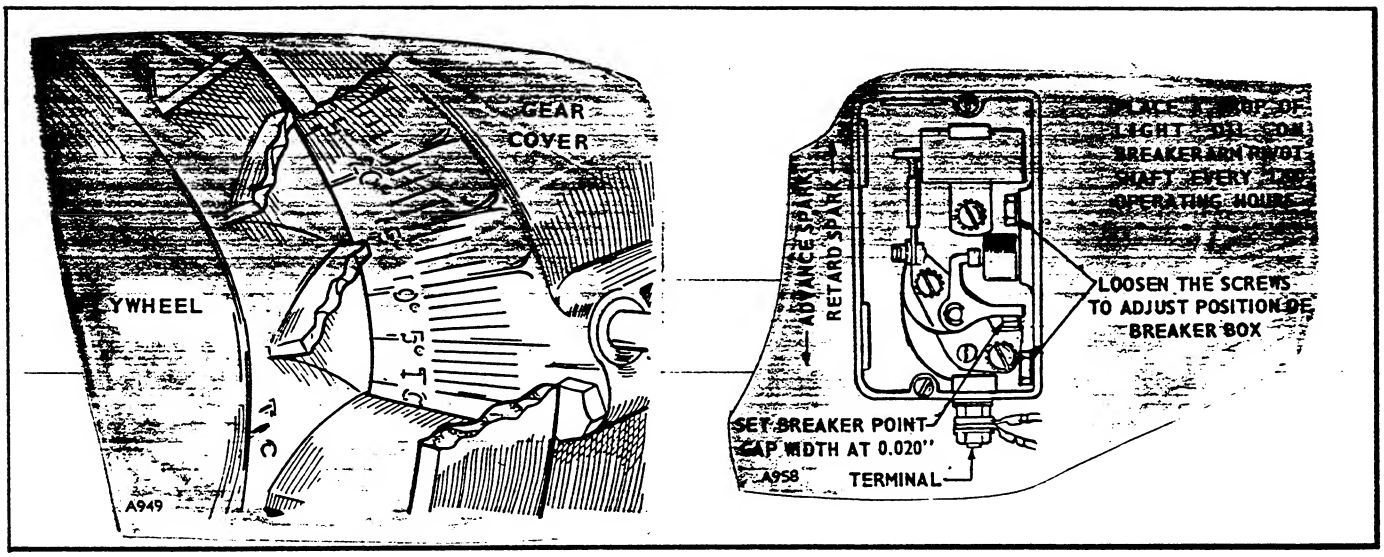


FIG. 11 - IGNITION TIMING

To accurately check timing, use an automotive type timing light with engine running.

To check timing without running the engine, connect a continuity test lamp set across the ignition breaker points. Touch one test prod to the breaker box terminal (to which the lead to the coil is connected), and the other test prod to a good ground on the engine. Turn the crankshaft against rotation (backwards) until the points close. Then slowly turn the crankshaft with rotation. The lamp should go out just as the points break.

6. Install the breaker box cover.

CONDENSER

A defective condenser can result in burned points, weak or intermittent spark, or complete failure of ignition spark. The condenser can be tested with an ohmeter if trouble is suspected. Remove the condenser lead and a good ground on the engine. At first, a low resistance should be indicated, however this should quickly rise to a high value. If low resistance is indicated continually, then condenser is definitely faulty and must be replaced.

MAGNETO STATOR INSTALLATION

The stator is located behind the flywheel. To expose the stator, remove the blower housing. Loosen the flywheel bolt a few turns. While pulling or prying outward on the flywheel, strike the flywheel bolt a sharp endwise blow to loosen the flywheel. Remove the flywheel bolt and carefully pull the flywheel off the crankshaft. Connect the shorter coil lead (ground) to the stator mounting screw. Connect the longer coil lead to the breaker box (either terminal). Be sure the longer lead is held in place to prevent rubbing on the flywheel.

FLYWHEEL MAGNET

The Onan flywheel magnet should retain its magnetism for life of the unit. However, the magnet can accidentally be demagnetized. Hard blows or dropping can cause loss of magnetism. For this reason, a flywheel puller is preferred over the "knock off" method for removing a flywheel.

The flywheel magnets are charged so that in checking with a magnetic compass, the NORTH seeking end of the needle should be attached to the leading magnet pole. Be sure the charger is connected to charge with the correct polarity.

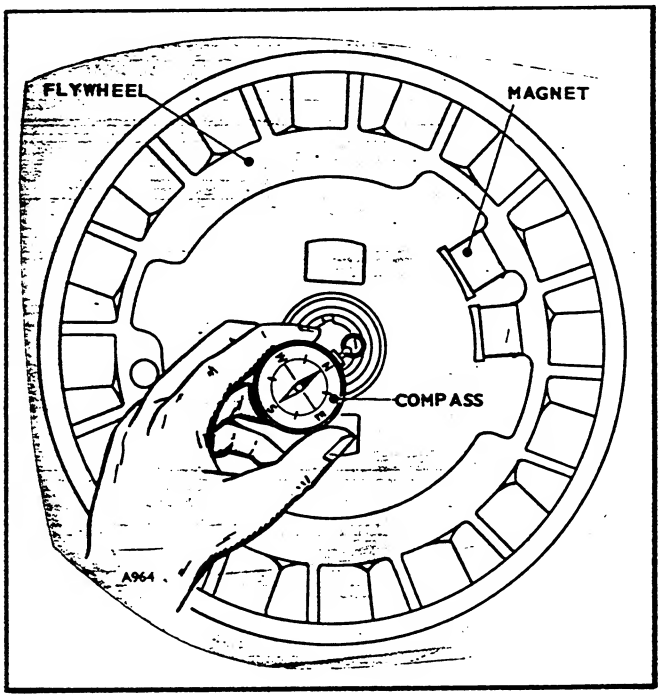


FIG. 12 - FLYWHEEL MAGNET

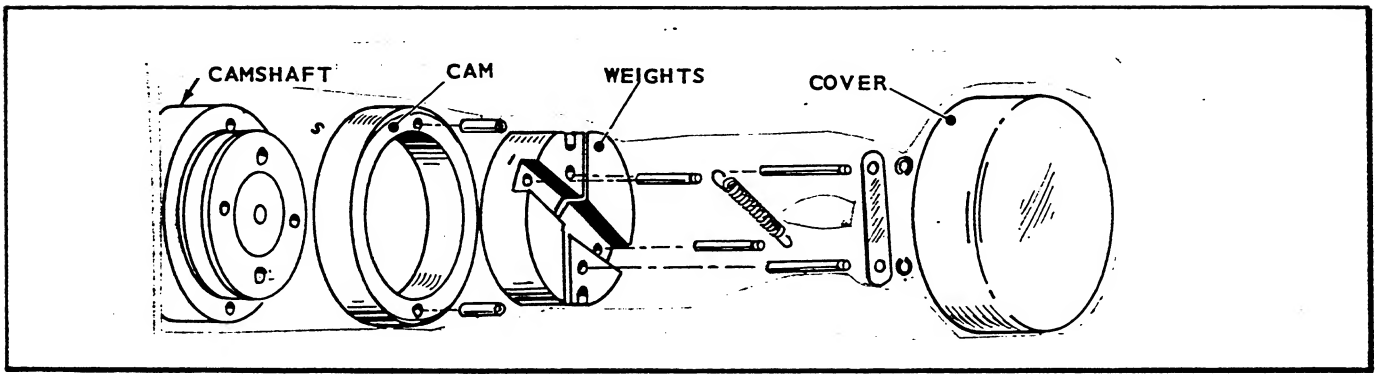


FIG. 13 - IGNITION ADVANCE MECHANISM

IGNITION ADVANCE MECHANISM

General: Ignition advance timing provides optimum ignition timing which provides better fuel economy and increased horsepower.

The spark advance mechanism, located at the rear of the camshaft, is operated by centrifugal force. As engine speed is increased weights push the cam, advancing the spark. As engine speed is decreased the weights release the cam, retarding the spark.

When the engine is stopped, ignition timing is automatically retarded to 5° BTC resulting in easier starting.

IMPORTANT: *Should the ignition advance mechanism become dirty or gummy, and cause it to stick closed (retarded), engine power will be reduced.*

If the mechanism sticks in the advanced position, the engine will possibly "kick back" during cranking.

Cleaning: The ignition advance mechanism can be exposed for cleaning by either removing the cup-shaped cover in the crankcase rear camshaft opening, or by removing the camshaft from the engine.

DO NOT INDENT the cup-shaped cover as it will interfere with the movement of the weight mechanism.

Checking Advance Mechanism

1. The timing marks will be visible through the flywheel.
2. Connect timing light to spark plug.
3. Start engine and run at 3600 rpm.
4. View the timing marks using a timing light. The "TC" flywheel mark should align with the 24°-25° mark on gear cover.
5. While watching the timing marks with the timing light, slow the engine to below 800 rpm. If the "TC" mark on the flywheel disappears and then reappears when the engine is brought back to speed, the mechanism is operating properly.
6. If the ignition advance mechanism DOES NOT REACT as described in step #5, remove, clean, and/or replace as necessary.
7. Replace the Dot Button.

READI-PULL STARTER

Refer to Fig. 14 showing the Readi-Pull manual starter disassembled.

Caution: *The recoil spring may unwind and cause injury if let fly wildly when starter is disassembled or assembled.*

The sheave hub bearing (16) has a recess which was packed full of grease at the factory. Normally, no additional lubrication is required. However, if the starter is disassembled for some other reason, add grease to the bearing and to the spring pawls (11) where they contact the ratchet arm (13).

To install a new rope or internal parts, remove the starter from its mounting ring by removing the four clamping screws.

To install a new rope, rotate the sheave (10) with crankshaft rotation direction to fully tighten the spring (8), back up only as necessary to align the hole in the sheave with the slot in the cover (5), clamp the rope to the sheave, then when released, the rope will wind on the sheave.

To install a new recoil spring, remove the sheave from the cover. Wind the spring, with its rivet heads outward, forming a coil small enough to be inserted in the recess of the starter cover. It may be necessary to tie the spring with a piece of wire to prevent its unwinding during installation unless other help is available. Place the spring in the cover recess in crankshaft rotation direction. Remove the tying wire if used. While holding the spring to prevent its unwinding, install the inside end of the spring on the roll pin (7) in the cover. With the pull rope removed, install the sheave assembly in the cover so that the tab on the sheave enters the outside end loop of the recoil spring. Be sure the thrust washer (9) is in place. Then install the pull rope.

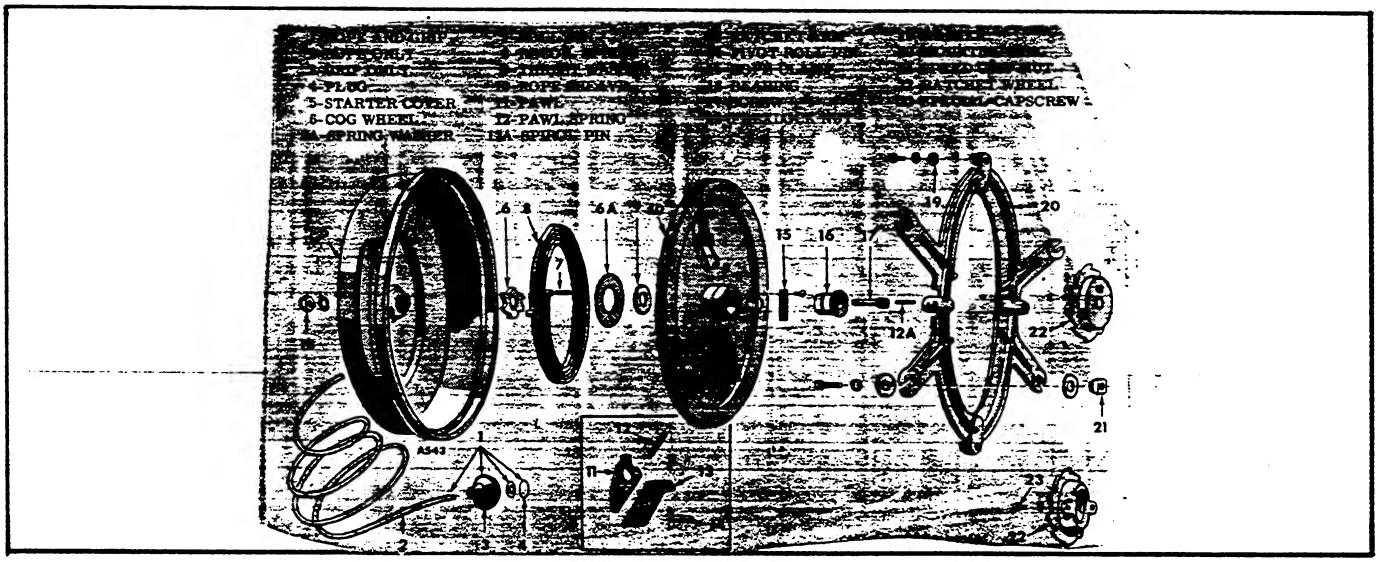


FIG. 14 - MANUAL STARTER

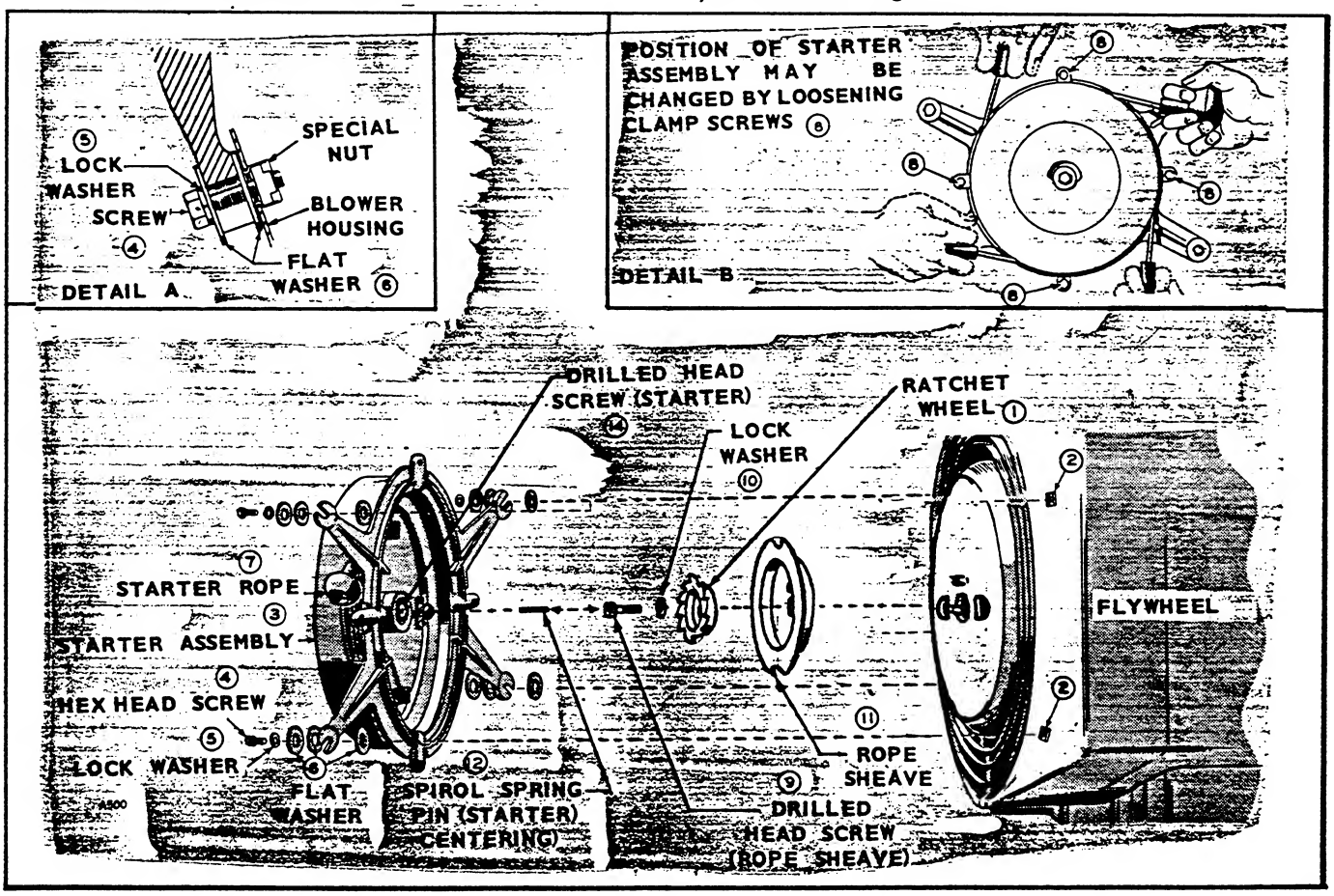
Spring breakage is much less common than spring fatigue due to long usage. In either case, the spring should be replaced. Cleaning and lubricating the pawls, and ratchet arms in the rope sheave will improve a sluggish acting recoil. To temporarily extend the life of a fatigued spring, try rewinding it *inside out* (rivets heads inward).

To install a ratchet arm (13) in the sheave, the pawl (11) must first be removed. The ratchet arm will fit in only the correct position. The spring pawl must be installed with its flat edge against the ratchet arm.

The anti-back lash cogwheel (6) is an easy press fit on the starter cover

INSTALLING THE STARTER

See that the engine blower housing is in good condition. If the mounting holes are worn or if the blower housing is otherwise damaged, replace it with a new one. Refer to Fig. 15.



1. Install the new ratchet wheel (1) against rope sheave (11) using lock washer (10) and flywheel mounting screw (9). Discard the large flat washer from engines so equipped. Engage drive hole with flywheel boss.
2. Four special nuts are supplied for mounting the starter to the blower housing. If the blower housing is not already fitted with similar nuts, remove the blower housing and install the nuts as shown in detail A. Reinstall the blower housing, tightening securely in flywheel mounting screw. While holding in position, mount the starter, using a hex head screw, lock washer, and two flat washers at each mounting arm as shown in detail A. Tighten the mounting screws securely.
3. Install centering pin (12) in starter center screw (14) allowing 3/8" to protrude. For reinstallations, readjust pin depth.
4. Center the starter assembly over the ratchet wheel with the centering pin engaging the center hole of the drilled head screw, making sure that the pull rope will not rub against one of the clamping screws.
5. The direction of pull on the starter rope is adjustable to fit the requirements of the individual installation. See detail B. To change the direction of pull, loosen the four clamp screws (8) and turn the starter in its mounting ring to the desired position. Try the starter several places. Tighten the four clamp screws securely.

FIG. 15 - MANUAL STARTER ASSEMBLY

PARTS!

LOOK FOR THEM . . . . ASK FOR THEM . . . . BE SURE YOU GET GENUINE ONAN REPLACEMENT PARTS. NEVER ACCEPT SUBSTITUTES! IF YOU WANT TO MAKE YOUR ONAN ELECTRIC PLANT OR ENGINE AS GOOD AS NEW, WATCH FOR THE GREEN AND WHITE LABEL WITH THE IDENTIFYING WORDS: GENUINE ONAN PARTS.

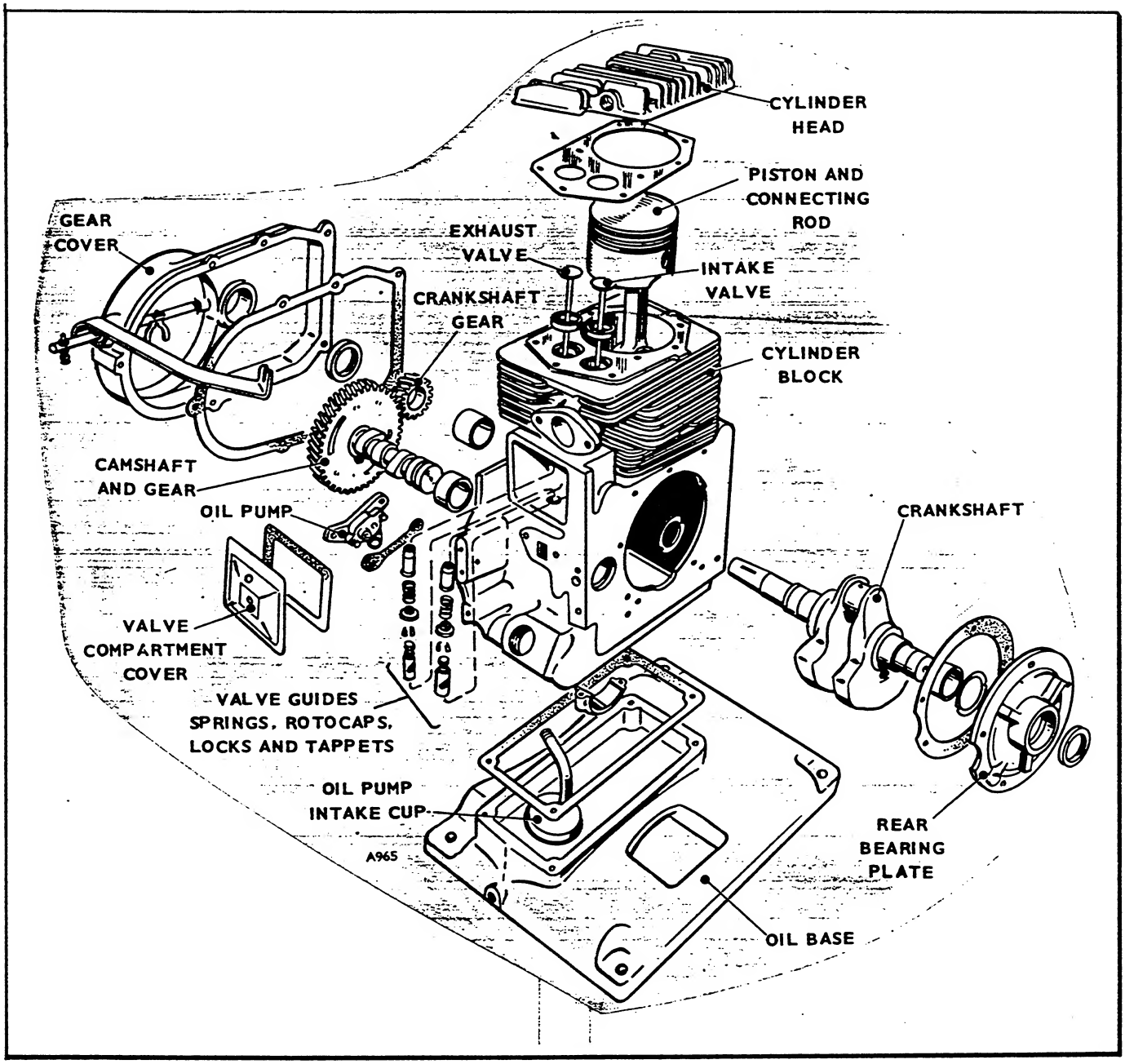
ENGINE REBUILDING

ENGINE REBUILDING

When engine disassembly is necessary – remove complete assemblies (tear down individual components like carburetor, fuel pump, breaker mechanism, etc., as bench jobs). *Use special tools available.*

DISASSEMBLY

A. Common sense will dictate proper order of disassembly. As disassembly progresses, the order may be changed as will become self-evident.



MAJOR ENGINE COMPONENTS

B. A suggested procedure would be as follows:
1. Housing, shrouds, blower housing, air cleaner
2. Flywheel – using puller or pry-bar method
3. Gear Cover – protect oil seal from keyway damage
4. Crank Gear – use puller and gear puller ring
5. Loose accessories such as carburetor and manifold assembly, fuel pumps, oil filters, fuel filter, starter, and generator.
6. Control box and generator (lift all generator brushes) tag all wires for identification
7. Drain oil – discard oil removed
8. Cylinder head
9. Valves, springs rocker arms
10. Camshaft and gear, rear bearing plate, oil pump
11. Piston, connecting rods, bearings
12. Crankshaft
13. Try to analyze reasons for any parts failure and necessity of the repair.
14. Cleanliness and neat orderly work area makes the job easier to do.
15. Use proper meters and gauges. Observe if cylinders require boring, crankshaft needs grinding, or other major shop work necessary
16. Check generator and static exciter (if used). Use growler, test light (buzzer), or ohmeter for armature or field coil shorts, grounds, or opens.

ASSEMBLY (USE GENUINE ONAN PARTS)

A. Engine assembly procedure is normally the reverse of disassembly – observing proper clearances of bearings, connecting rods, proper fitting and sizing of pistons, rings, etc.

B. Follow proper recommended procedure for fit of valves, adjusting clearances, and torque of all special items. Use a torque wrench to assure proper tightness without danger of stripping threads.

C. As each internal engine part is assembled, use crank (or wrench) and turn over engine making certain it turns freely. If tightness is noted after any operation you then know your last step is responsible.

D. As each internal engine part is assembled, coat it heavily with oil, (the same grade to be used in the crankcase). During the first few critical moments of operation, the engine will depend on this lubrication.

E. After you have the internal engine parts reassembled, the engine should turn over freely when cranked. If reasonable care and attention has been given, the engine will operate efficiently.

F. At this point, it is a matter of mechanically adding the outside accessory items to the block assembly. *Order of assembly is reverse of disassembly.*

G. When engine is complete, install generator and plant control. Check the tagged wires. Use wiring diagram to connect generator leads to control, and from control to engine leads. All wires are marked for correct identification. If plant is to work properly, wires must be connected correctly.

H. Engine-generator is now ready for testing. Follow suggestions given on *Testing* and *Adjusting Plants.* Before final test and adjustments run the plant about 15-minutes under light load to reach normal operating temperature.

ASSEMBLY SUGGESTIONS (Things to keep in mind during engine assembly)

A. *See Onan Tool Catalog (900-19)* – many items require a special tool for correct installation. Some of these tools are:
1. Oil seal driver and guide, bearing driver
2. Valve spring compressor, valve lock replacer, valve guide driver, and valve seat, remover.
3. Gear puller and gear puller rings
4. Piston ring spreader and compressor
5. Flywheel puller, pry bar, armature puller
6. Torque wrench, Plastigauge (for correct bearing clearance)
7. Load test panel, armature growler, gas pressure gage, (for manometer)

B. Wet holes in crankcase (holes through crankcase) always use copper (gasket) washers.

C. Nuts, bolts, and screws that do not require exact torque should be tightened snugly, then add 1/4 extra turn.

D. Select proper length of any screw or bolt and position in hole. Make sure they do not *bottom.*

E. Gasket kits sometimes cover more than (1) engine. Therefore, select gasket of correct size and shape for part being used with. Always use new gaskets.

F. When disassembling engine, mike bearing plate gasket thickness. Then select proper gasket thickness for correct end play.

G. When assembling crankshaft, make sure bearing thrust washers are in proper position supported by bearing stop pins. Use cup grease to hold in place.

H. When installing gearcase cover, put a dab of grease on roll pin so governor cup can be aligned.

I. Crank gears are easier to remove and install if heated.

J. Service manual (for any specific model) should be read carefully for correct ignition timing.

K. After making overhaul or repair, the engine can usually be started by opening the main gas needle about two (2) turns, and the idle needle about one (1) turn. Then make final adjustments after engine reaches normal operating temperature.

L. Allow some gear lash (approximately .005") in oil pump. *Do not install gears tightly against each other!*

TESTING AND ADJUSTING PLANTS

Preparation

1. Oil in crankcase.
2. Air cleaner serviced
3. Fuel line connected, primed to fill carburetor.
4. Load connected.
5. Battery connected and charged.
6. Choke adjusted.
7. Spark plug clean and adjusted.
8. Proper ventilation, cooling.

OPERATION

1. Start engine (manual choke if necessary).
2. Adjust brush rig.
3. Run engine 15-minutes – to bring up to operating temperature.
4. Oil leaks? Loose electrical connections? Fuel lines tight? Exhaust leaking?
5. Adjust carburetor for initial starting.

ADJUSTMENTS

1. Governor, speed, sensitivity.
2. Carburetor: idle, main gas, throttle stop.
3. Meters connected, load test panel.
4. Vacuum Booster, to help at 1/2-load.
5. Output: volts, amps, watts, frequency.
6. AC – DC meter checks.

IMPORTANT: *For complete customer satisfaction repaint unit (Onan Green – spray can #525P137, or Onan White – spray can #525P216) and apply instructions from Kit #98-1100C or Marine Kit #98-1807.*

VALVE SERVICE

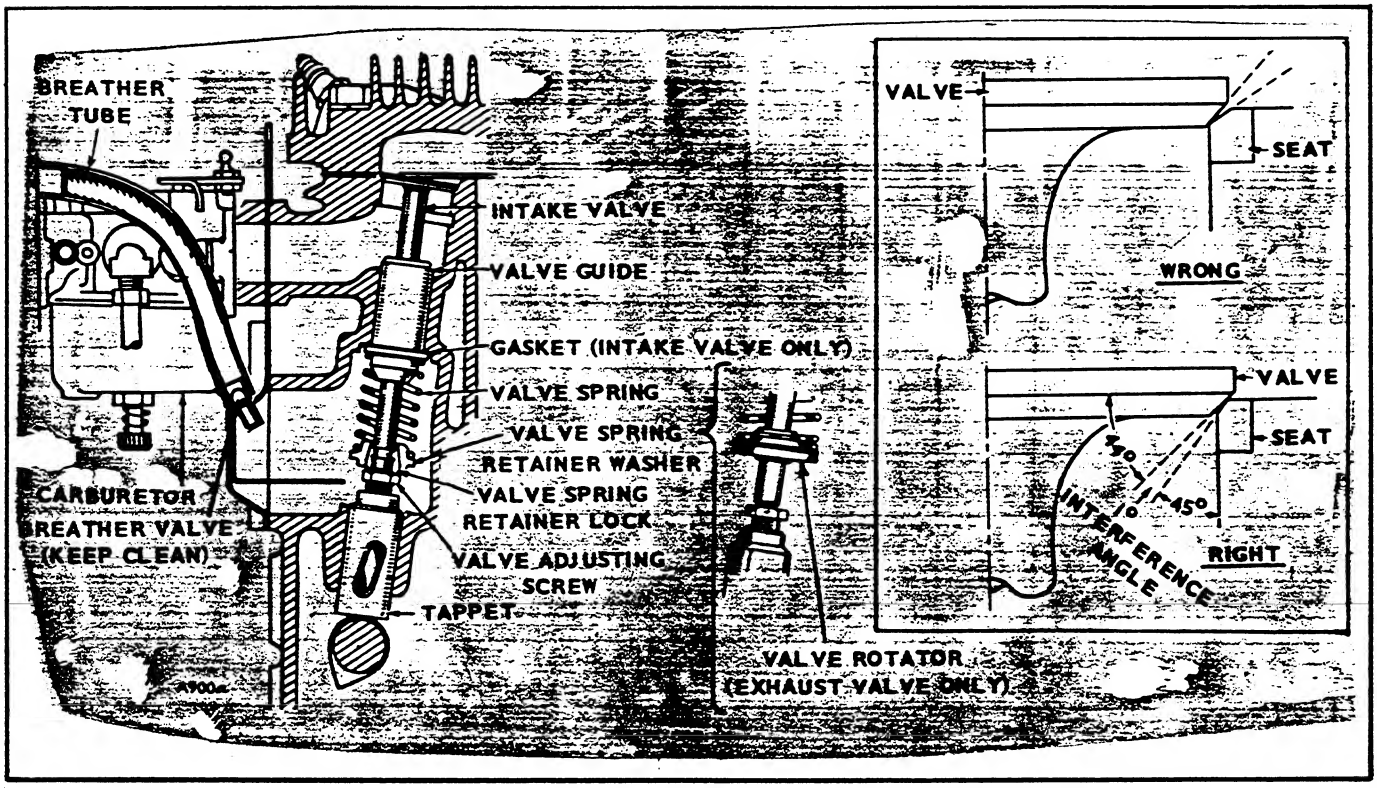
Properly seating valves are essential to good engine performance. The aluminum cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head, rap sharply on the edge with a soft faced hammer, taking care not to break any cooling fins. A conventional valve spring lifter may be used when removing the valve spring locks. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be placed from inside the valve chamber. This gasket (Prior to Spec. C) must contact tightly against the upper valve chamber surface. Valve locks are the split, tapered type, the smaller diameter of which must face toward the valve head. Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

The valve FACE angle is 44°. The valve SEAT angle is 45°. This 1° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life.

Valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where stellite faced valves and seats are used. Valve faces should be finished in a machine to 44°. Valve seats should be ground with a 45° stone, and the width of the seat band should be 1/32 to 3/64" wide. Grind only enough to assure proper seating.

Remove all grinding dust from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if marks rub off uniformly when the valve is rotated part of turn against the seat.
Lightly oil the valve stems and assemble all parts removed. Adjust the valve tappet clearance.



TAPPET ADJUSTMENT

Tappet clearance may be easily checked after first removing the valve compartment cover and the blower housing. Crank the engine over by hand until the intake valve (the one nearest the carburetor) open and closes. Continue turning the flywheel slowly until the mark on the flywheel is in alignment with the "TC" mark on the gear cover. The correct tappet clearance for both the intake and exhaust valves appear in the Table of Clearance. Tappets are fitted with self locking adjusting screws. Use a 7/16" wrench for the screw, and a 9/16" wrench for the tappet when making any adjustment.

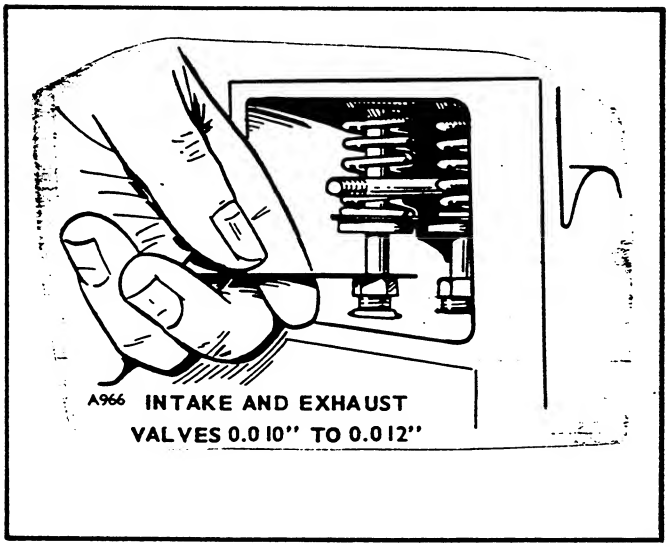


FIG. 18 - VALVE ADJUSTMENT

GEAR COVER

When removing the gear cover, it is not necessary to remove the magneto assembly from the cover. Just disconnect the spark plug lead at the spark plug, and stop wire.

When installing the gear cover, make sure the pin in the gear cover engages in the metal lined hole of the governor cup. Turn the governor cup so that hole is in an upward position where it corresponds to the 12 o'clock position on the face of a clock. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal.

REMOVAL OF VALVE SEAT

1. Use a knockout tool made as shown in Fig. 19
2. Insert the knockout tool under the port side of the valve seat, as shown in Fig. 20. The outer end of the knockout tool should extend over the cylinder bore, and the sharp edge of the knockout tool at the joint between the seat and its recess in the cylinder block.

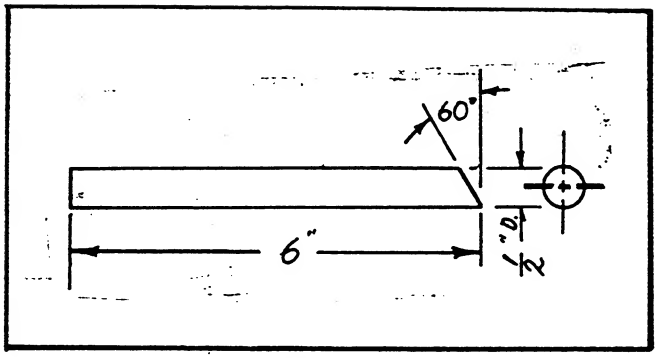


FIG. 19 - VALVE SEAT REMOVAL TOOL

3. Strike the end of the knockout tool a sharp blow with a light hammer. This blow should crack the valve seat insert, after which it may be removed.

CAUTION: *Do not strike repeated blows on the end of the knockout tool and force it underneath the seat, as such action will cause damage to the counter bored recess for the valve seat insert. If the surface of the recess is damaged, the new seat insert will not fit properly.*

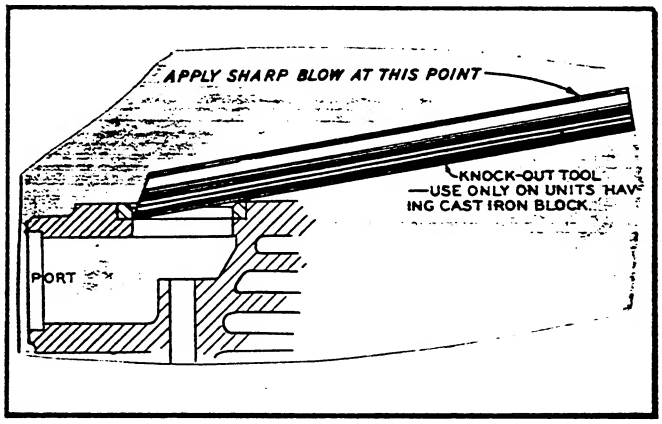


FIG. 20 - VALVE SEAT REMOVAL

Because a slight amount of recess metal will be removed in this operation, an oversize replacement seat must be used.

After the old valve seat insert has been removed, clean out any carbon or metal burrs from the seat insert recess. The cylinder block should then be placed in an oven and slowly and evenly heated to a temperature of approximately 325° F. (163° C.).

Place the new valve seat insert in a covered box filled with dry ice (solidified carbon dioxide) and allow it to cool and contract for approximately one-half hour. Just before removing the seat insert from the box, place the driver tool in the box and cool for a few minutes before using it.

The chilled valve seat insert may be easily and accurately inserted in the cylinder block recess using the proper driving tool and a hammer (Fig. 21). Insert the pilot of the tool in the valve guide hole in the cylinder block and quickly drive the valve seat insert in so that the insert goes evenly to the bottom of the counterbored recess in the cylinder block. Make certain that the valve seat insert rests solidly on the bottom of the recess all the way around its circumference.

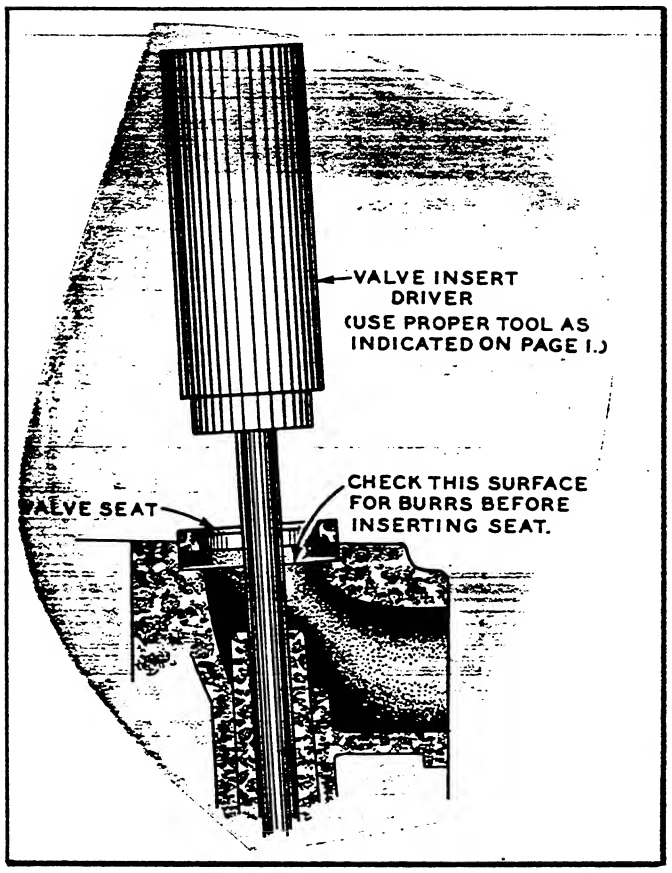


FIG.21 - INSERTING NEW VALVE SEAT

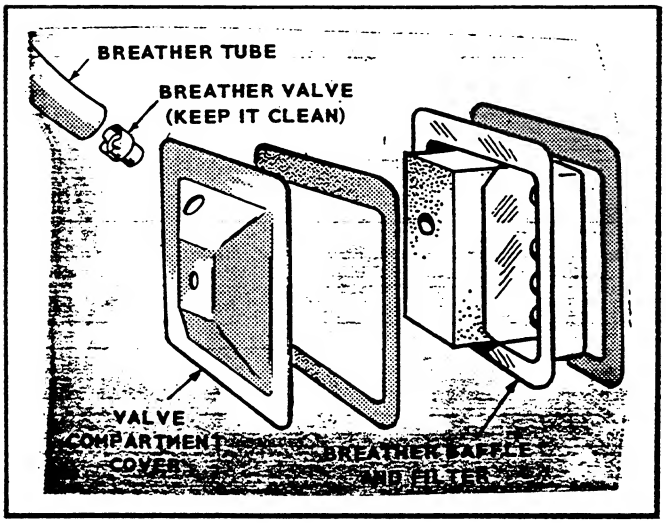


FIG.22 - BREATHER VALVE

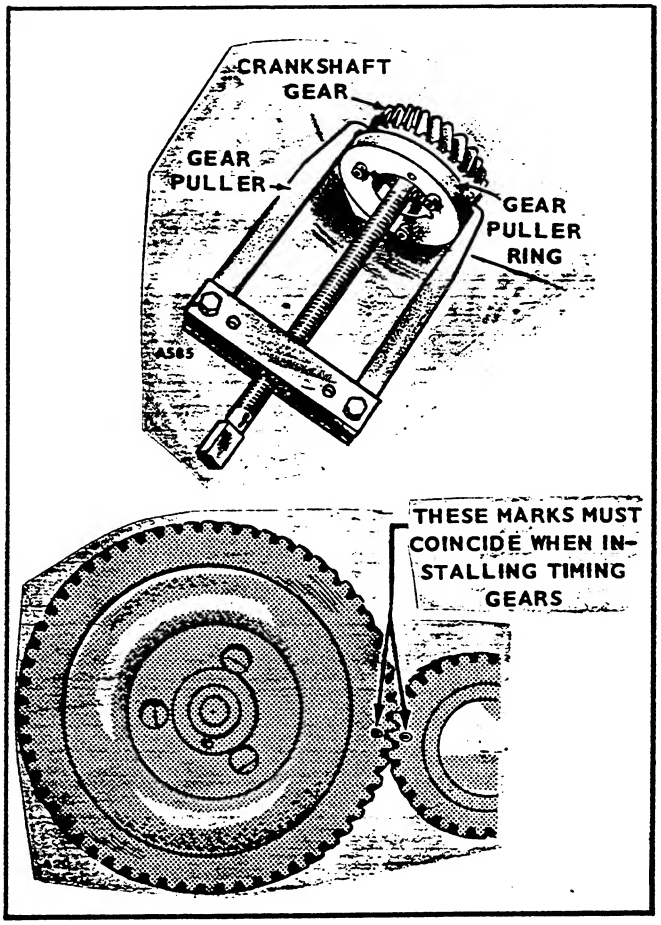
BREATHER VALVE

Remove the hose which carries expelled air from the breather valve at the valve compartment cover, to the air cleaner. Loosen the valve with pliers. Occasionally the valve will lift out and remain inside the hose. Wash the valve in kerosene or other suitable solvent. dry and replace. The valve must work free and the hose must not be restricted to prevent expelled air from re-entering the crankcase. Install parts removed

TIMING GEARS

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, install both gears new, never one only. Use a gear puller to remove the crankshaft gear.

The camshaft gear is pressed on and keyed to the camshaft. The camshaft and gear must be removed as an assembly, after first removing the crankshaft gear lock ring and washer. Before removing the camshaft and gear assembly, remove the cylinder head, valve assemblies, fuel pump, tappets. After removing the governor cup assembly from the gear, the camshaft may be pressed out of the gear by use of a hollow tool or pipe which will fit over the camshaft center pin. Do not press on the center pin or damage it in any way. The governor ball spacer is a press fit to the camshaft gear.



- TIMING GEARS

When pressing a camshaft gear onto the camshaft, be sure the gear is started straight and that the key is properly in place. Install the governor cup assembly before installing the camshaft gear in the engine.

Note that each timing gear is stamped with "O" mark near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine. Be sure, when installing the camshaft gear and shaft assembly, that the thrust washer is properly in place behind the camshaft gear. Replace the retaining washer and lock ring to the crankshaft.

GOVERNOR CUP

The governor cup may be removed from the cam gear and shaft after first removing the small lock ring from the camshaft center pin. Catch the governor flyballs as the cup assembly is removed.

If a new governor cup is being installed, the distance from the small lock ring on the center pin to the face of the governor cup must be exactly 7/32" when the cup is pressed back against the flyballs as far as possible. If the distance is too small, carefully dress the face of the cup as required, being sure to remove any burr from the inside of the cup bore. If the distance is more than 7/32", carefully press the pin in the required amount. Do not damage the pin, as it is difficult to replace it in the field. Replacement of governor flyballs is easier if the plant is tipped backward with the timing gears upward. Be sure that all flyballs are replaced and evenly spaced. Replace governor cup if it is grooved or nicked.

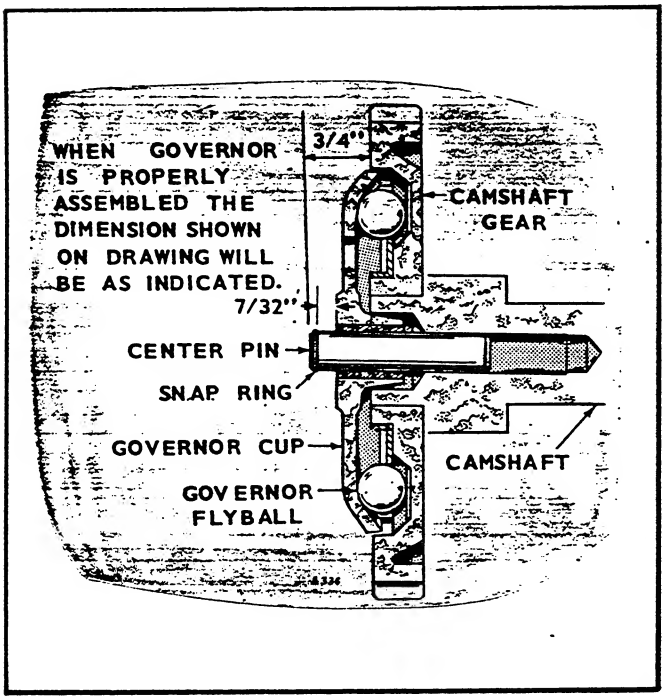
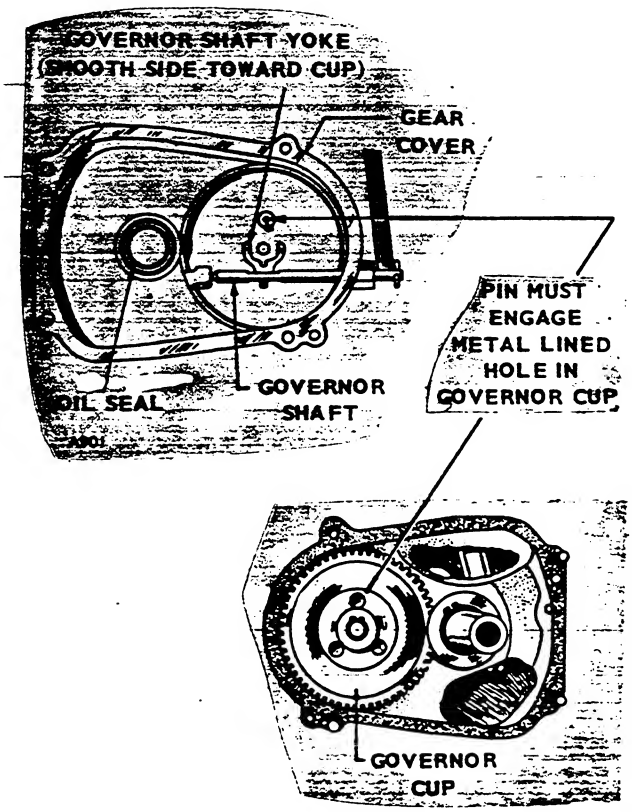


FIG.24 GOVERNOR CUP INSTALLATION



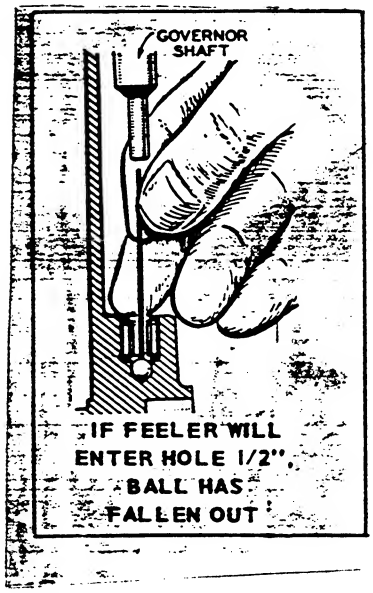


FIG.25

CYLINDER

The cylinder wears very little in normal service. If through improper lubrication or accident, the cylinder wall should become scored or worn badly, the cylinder may be rebored and honed to accommodate a new piston and rings of one of the available oversizes. Pistons and rings are available in .010", .020", .030" and .040" oversizes. Some engines were fitted at the factory with a .005" oversize piston, and are so indicated by a letter "E" following the engine serial number stamped on the side of the crankcase, and on the nameplate. If the cylinder is not being reconditioned, but new piston rings are being installed, remove any ridge which may have formed at the top of piston ring travel in the cylinder bore. Use standard size rings on a .005" oversize piston.

PISTON AND RINGS

The piston and connecting rod assembly are removed through the top of the cylinder. The piston is fitted with two compression rings and one oil control ring.

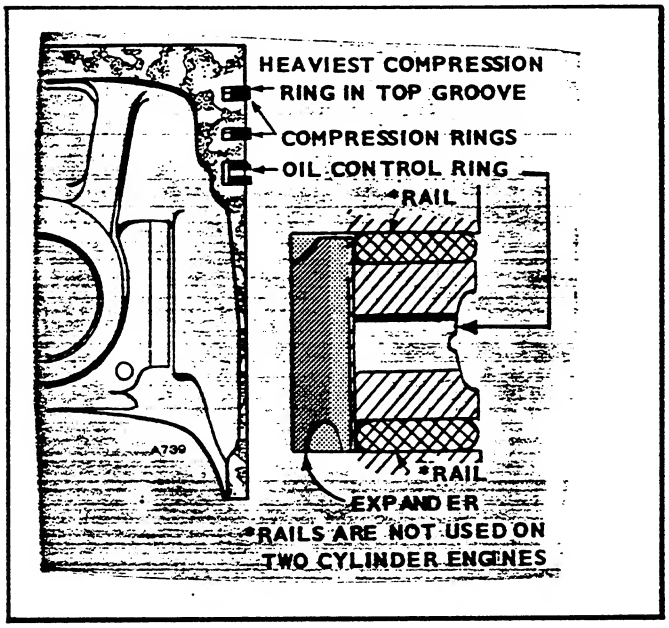


FIG.26 - PISTON RINGS

The piston ring grooves should be cleaned of any carbon deposits, and the oil return holes in the lower groove must be open. Before installing new rings on the piston, check the ring gap by placing each ring squarely in the cylinder at a position corresponding to the bottom of its travel (Fig. 27). The gap between the ends of the ring should be as given in the Table of Clearances. Rings which are slightly oversize may be filed as necessary to obtain the correct gap, but do not use rings which require too much filing. Standard size rings may be used on a .005" oversize piston. .010", .020", .030" and .040" oversize rings are to be used on .010", .020", .030" and .040" oversize pistons, respectively. Rings of the tapered type are usually marked "TOP" on one side, or identified in some other manner, and the ring must be installed with this mark toward the closed end of the piston. Space each ring gap one third of the way around the piston from the preceding one, with no gap directly in line with the piston pin. The bottom piston ring groove should be fitted with an oil control ring and the two upper grooves fitted with compression rings.

The piston is fitted with a full floating piston pin. The pin is kept in place by two lock rings in the piston, one at each side. Be sure these lock rings are properly in place before installing the piston and connecting rod in the engine. Correct piston to cylinder clearance appears in the Table of Clearance.

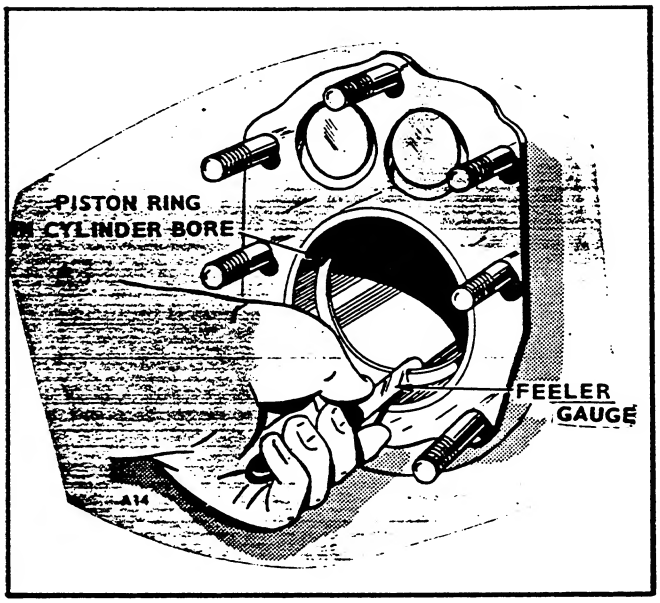


FIG.27 - PISTON RING GAP

CONNECTING ROD

Mark the connecting rod before removing it to assure proper re-assembly. Connecting rod inserts are available in standard size or 0.010", 0.020", and .030" undersize.

The connecting rod and piston assembly must be properly aligned before assembly to the engine. Aligning should be done on an accurate aligning gauge by a competent operator. Misalignment may cause rapid wear of piston, pin, cylinder and connecting rod.

OIL PUMP

To remove the oil pump it is necessary to detach the intake cup assembly, as illustrated.

Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for gaskets, the component parts of the pump are not available individually. The suction cup is available separately. Install a new pump assembly if required.

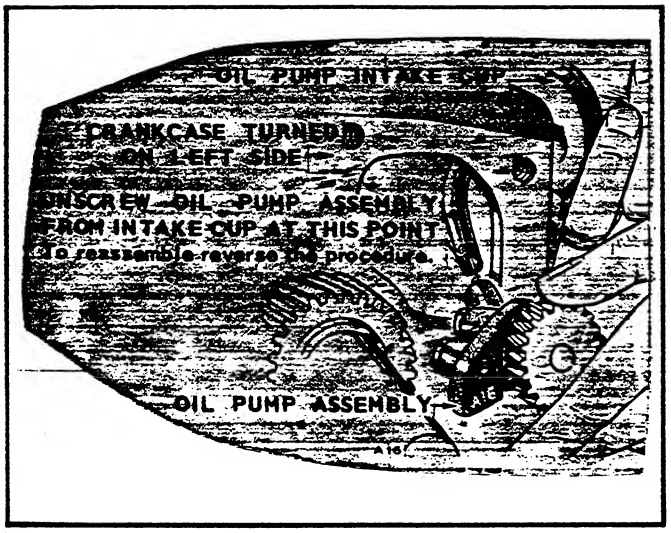


FIG. 28 - OIL PUMP ASSEMBLY

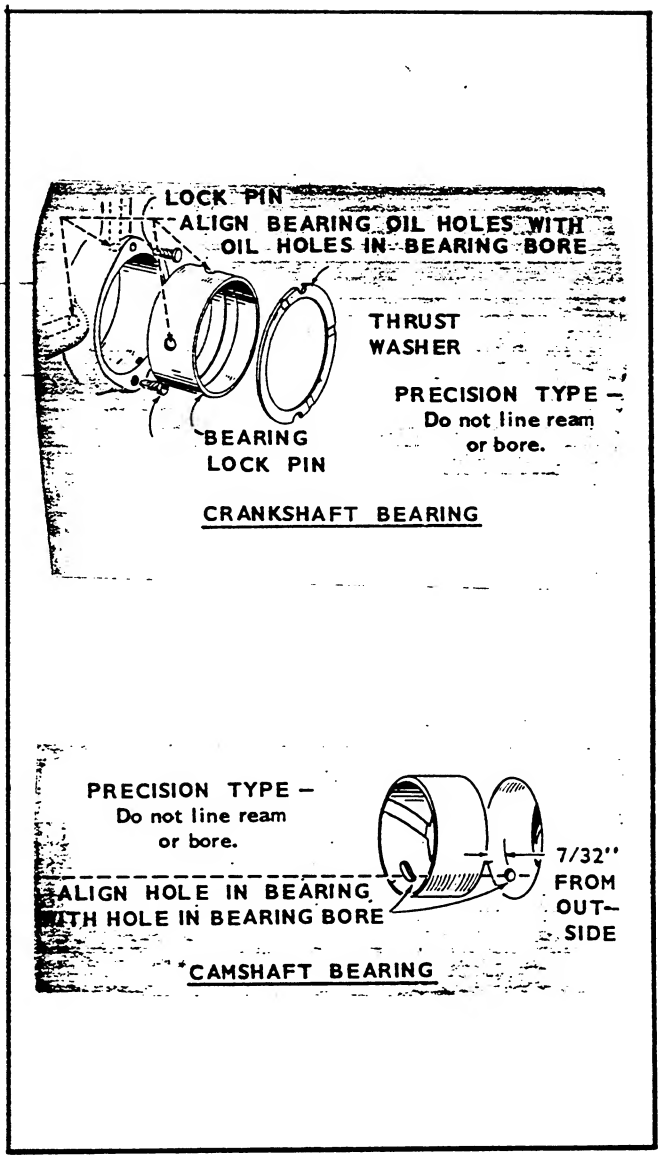


FIG. 29 - BEARING INSTALLATION

MAIN BEARINGS

Crankshaft main bearings are precision type and are available in standard size, 0.002", 0.010", 0.020", and 0.030" undersize. Precision type bearings DO NOT require line reaming.

Use a press or a suitable drive plug to remove bearings. Have the cylinder block supported to avoid distortion. Be careful not to damage the bearing bore, especially if a punch tool is used.

Warm the bearing plate and cylinder block slightly with hot water or by placing in an oven heated to 200° F. In an emergency, a blow torch may be used, but only a little heat is required. Avoid over-heating.

Align the oil hole in the bearing and the oil passage hole in the bearing bore (Fig. 29). Install the cold precision bearing so that the inside end of the main bearing is 1/16" to 3/32" back from the inside end of the bore to allow clearance for the machined radius of the crankshaft. If head of lock pin is damaged, use side cutters or Easy-out tool to remove and install new pin. Apply oil to thrust washer to hold it in place while installing the crankshaft. Oil grooves in thrust washers must face the crankshaft, washers must be flat (not bent) and washers two notches must fit over top lock pins to prevent riding on crankshaft.

CAMSHAFT BEARINGS

Camshaft bearings are precision type and do not require line reaming. Press the front camshaft bearing in flush with the bottom of the counterbore which receives the expansion plug.

OIL SEALS

When replacing either crankshaft oil seal, (Fig. 30), be sure the open side faces toward the inside of the engine. Use care not to turn back the edge of the oil seal or damage it in any way. The rear bearing plate must be removed to replace the rear oil seal. Remove the gear cover to replace the front oil seal. Seal expanding and driving tools are available through the dealer.

When installing the gear cover oil seal, tap the seal inward until it is 31/32 of an inch from the mounting face of the cover. Install new style, thin, open-face seal 1-7/64" from mounting face of cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander, or place a piece of shim stock around the end of the crankshaft, when replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

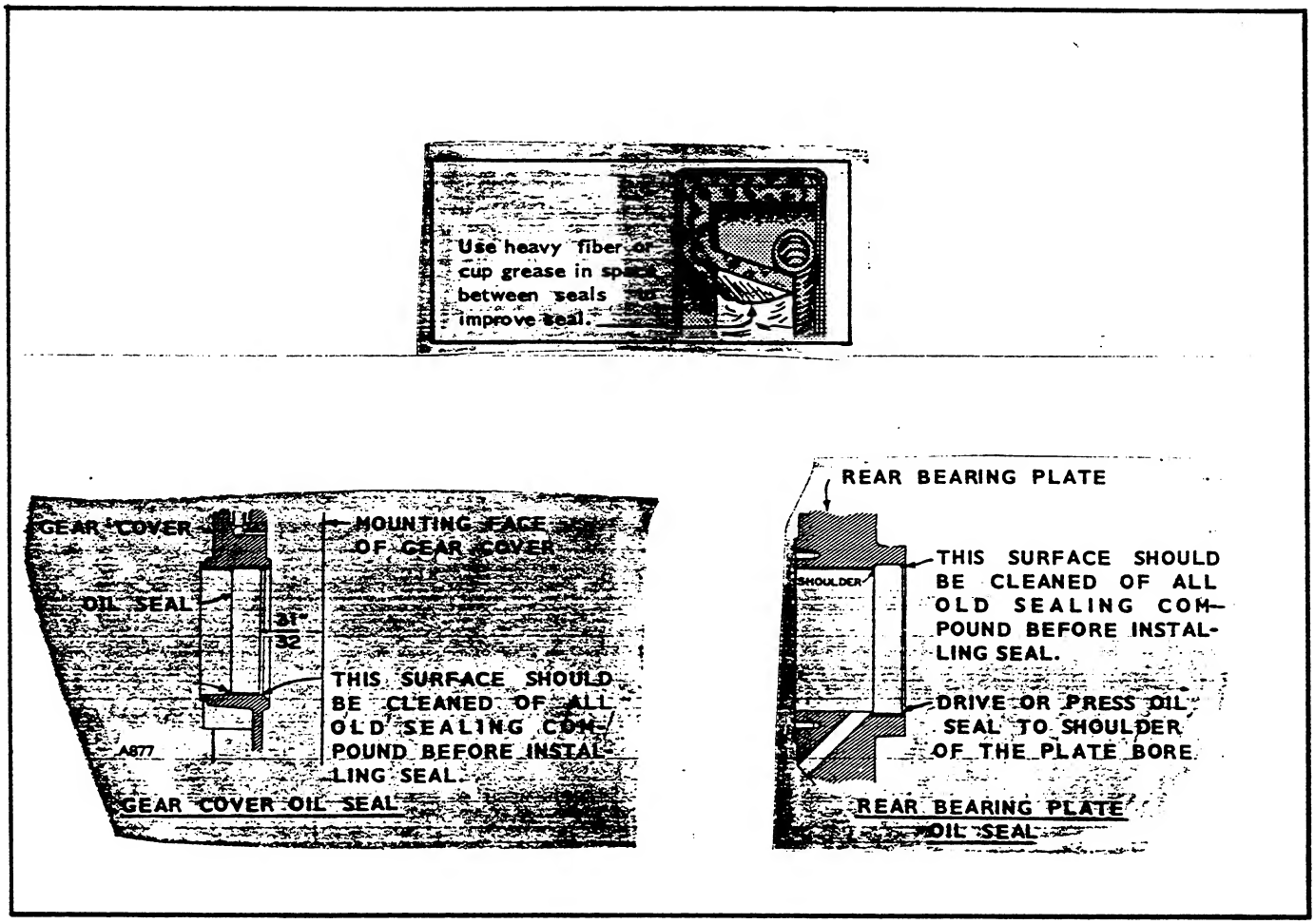
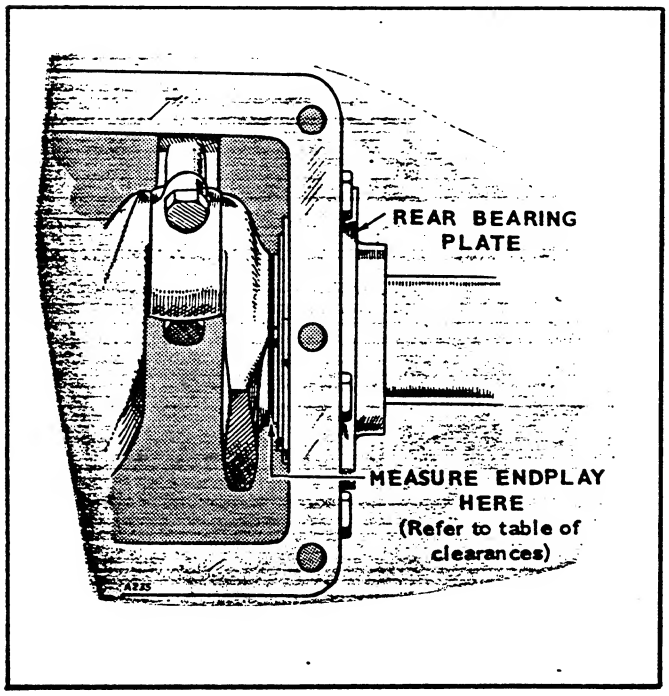


FIG.30 - OIL SEAL INSTALLATION



CRANKSHAFT END PLAY

Set crankshaft end play (Fig. 31) according to the Table of Clearances by using the correct thickness of gaskets between the rear bearing plate and the cylinder block. These gaskets must not block the oil passage on pressure lubricated units.

Before mounting generator to engine, tighten the rear bearing plate nuts. After securing generator to the engine, strike the flywheel screw sharply to re-adjust crankshaft forward end play (0.006'' to 0.012'').

VALVE COMPARTMENT OIL DRAIN

A drain hole from the valve compartment enters the crankcase. This hole must be unobstructed to provide for proper drainage of oil from the valve compartment.

SERVICE!

REMEMBER TOO, THAT ONAN AUTHORIZED SERVICE STATIONS, WITH THEIR FACTORY TRAINED PERSONNEL, HAVE THE BEST OF FACILITIES FOR COMPLETE OVERHAULING AND REBUILDING YOUR ONAN ELECTRIC PLANT OR ENGINE. SEE YOUR PARTS AND SERVICE CENTER FOLDER FORM F-115.

GENERATOR MAINTENANCE AND REPAIR

The generator normally needs little care other than a periodic check of the brushes, commutator and collector rings. If a major repair job on the generator should become necessary, have the equipment checked by a competent electrician who is thoroughly familiar with the operation of electric generating equipment. Continuity tests may be performed without disassembly of the generator.

Brush Replacement

Inspect brushes periodically. Brushes worn to the stamped ONAN name should be replaced. Replace springs if damaged or if proper tension is questionable. Never bend the constant pressure type spring over the edge of its support.

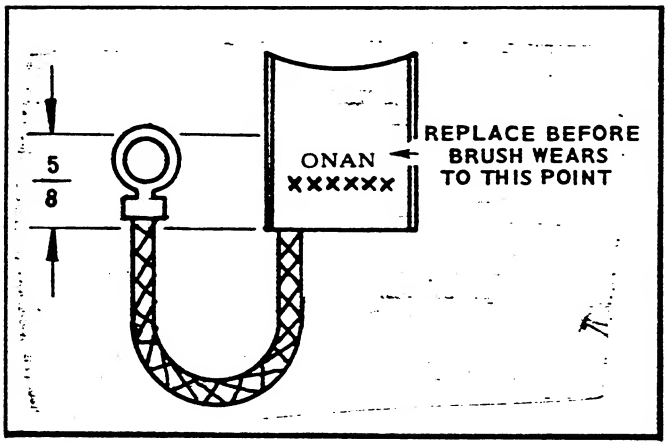


FIG.32 - BRUSH REPLACEMENT

CAUTION: If brushes are not replaced by the time they wear past the stamped ONAN name and number, severe damage to the selector ring may occur.

It is not necessary to remove the brush rig to install new brushes. Remove the end cover to expose the brush rig. Brushes and leads are then easily accessible. New brushes are shaped to fit and seldom need sanding to seat properly. Always use the correct brush as listed in the parts list, never substitute a brush which may appear to be the same, but may have different electrical characteristics. Be sure to tighten the brush lead terminal nuts. If some brush sparking occurs after replacing brushes, run the plant at a light load until the brushes wear to a good seat.

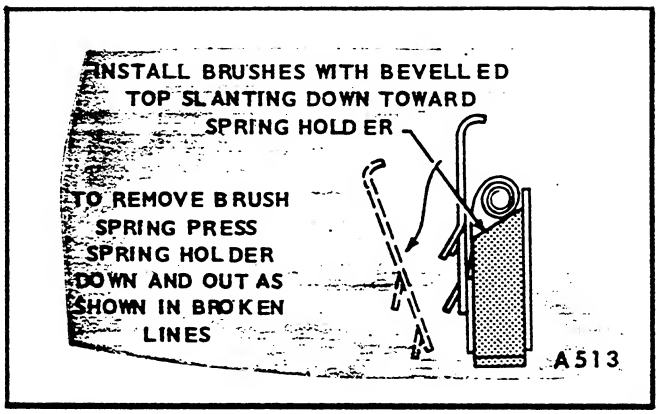


FIG.33 - BRUSH SPRING INSTALLATION

Brush Rig Position

On standard models, the neutral brush rig position is determined and permanently fixed at the factory. It cannot shift from neutral position.

Whenever a new brush rig or armature is installed, the brush rig must be rotated to the point of highest voltage (point of least arcing of the brushes) regardless of where the witness mark falls. This is commonly known as the *neutral* brush position.

Collector Rings

If the collector rings become grooved or out of round, or the brush surface becomes pitted or rough so that good brush film cannot be maintained, remove the armature and refinish the collector rings in a lathe. Remove or adequately shield the ball bearing during refinishing.

Collector rings acquire a glossy brown finish in normal operation. Do not attempt to maintain a bright newly machined appearing surface. Ordinary cleaning with a dry, lint free cloth is usually sufficient. Very fine sandpaper (#00) may be used to remove slight roughness. Use only light pressure on the sandpaper, while the plant is operating. Do not use emery or carborundum paper or cloth. Clean out all carbon dust from the generator.

Inspecting and Cleaning Rectifiers (Diodes)

When inspecting the diodes make sure they are kept free of dust, dirt, and grease. An excess amount of foreign matter on these diodes and heat sinks (brackets) will cause the diodes to overheat which will

result in diode failure. Blowing over them with filtered, compressed air periodically is a good practice.

Also check to see that the diodes are securely mounted and the leadwires are tight and in good condition.

Testing Diodes

Faulty diodes (either shorted or open) will cause abnormal generator operation. Check these individual diodes as follows:

1. Remove access cover from exciter end of the generator.
2. Isolate each of the diodes before proceeding.
3. To check, use an ohmeter to measure the resistance in the individual diode. Reverse the ohmeter leads and repeat resistance measurement. A good diode should have a high resistance value for one measurement and a low measurement when leads are reversed. If diode is not in good condition, replace with one known to be in good condition.
4. Check both diodes in accordance with step 3.

Replacement of Diodes

When replacing defective diodes, the following steps should be taken:

1. Unsolder leadwires from the diode terminal.
2. Use proper size wrenches to hold the body of the diode while removing nut attaching the diode to the heat sink (bracket).
3. Push the diode free of its mounting hole in the heat sink.
4. Be sure new diode is installed in the same position (or direction) as defective diode. These parts have directional arrows marked on them for this reason.

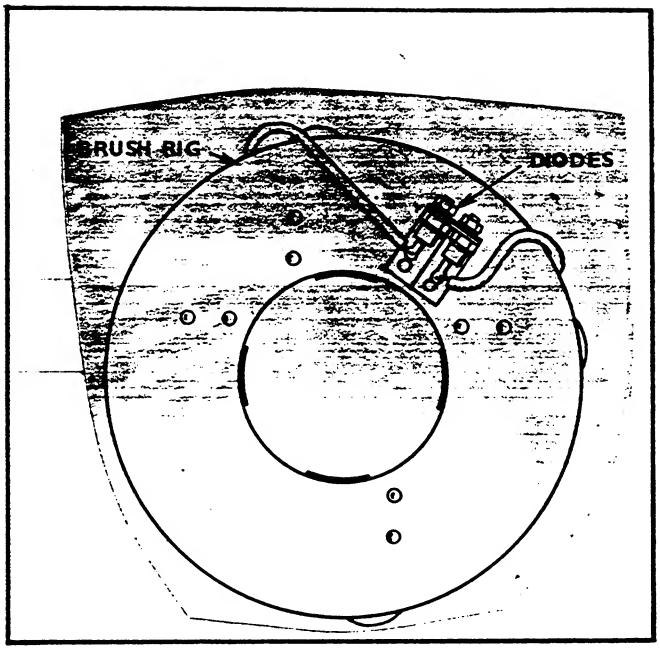


FIG.34 - DIODE LOCATION

5. Insert new diode into its mounting hole in the heat sink or bracket. Make sure heat sink surface is clean. Using nut and washer provided, secure diode, being careful not to allow it to turn while tightening nut. Tighten finger tight plus 1/4 turn.
6. Connect leadwires to appropriate terminals.
7. Solder the leadwires removed from defective diode to terminal of the new diode. Excessive heat can damage a diode. Use a needle nose pliers on the terminal between the soldering iron and the diode to absorb destructive heat.
8. Replace access cover.

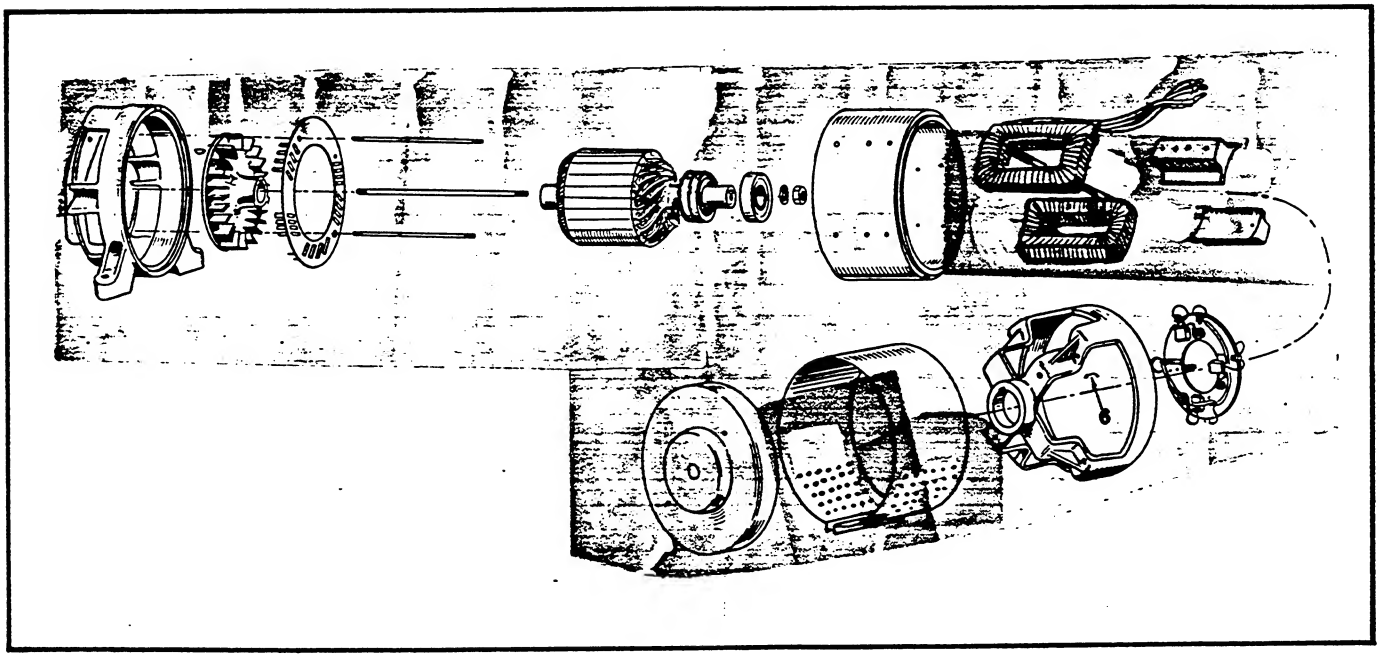


FIG.35 - GENERATOR DISASSEMBLY

GENERATOR DISASSEMBLY

The procedure is mostly self-evident. Always be sure that any lead disconnected in disassembly is legibly marked and its connection point carefully noted. Be sure that all brushes are lifted free of contact. Constant pressure type springs must be removed. If the brushes were pulled out past the mounted spring, the spring would be kinked and permanently damaged beyond further use.

It is seldom necessary to disturb the mounting position of the brush rig. It can remain mounted when removing the end bell or frame to which it is attached.

Remove generator through stud nuts. Hold both the end bell with its brush rig and the frame assembly, since they are separate parts, and remove them as one assembly from the adapter. Screwdriver slots in the adapter provide for prying the frame loose. Be careful not to let the frame assembly rest or drag on the armature.

To remove the armature, loosen the armature center nut just enough to avoid damaging the threads. While pulling outward on the armature, strike the nut a sharp endwise blow with a heavy soft faced hammer, to loosen the armature. The armature has an external taper which fits into the internal taper of the engine crankshaft. When the armature is loose, remove the stud nut and slide the armature carefully off the through stud.

Armature Open Circuit Test

The armature AC winding may be tested for an open circuit without removal of the armature.

To test the AC winding, be sure all brushes are lifted or removed. Place one test prod on each of the collector rings. If the test lamp does not glow, the AC winding is open circuited. See Fig. 36.

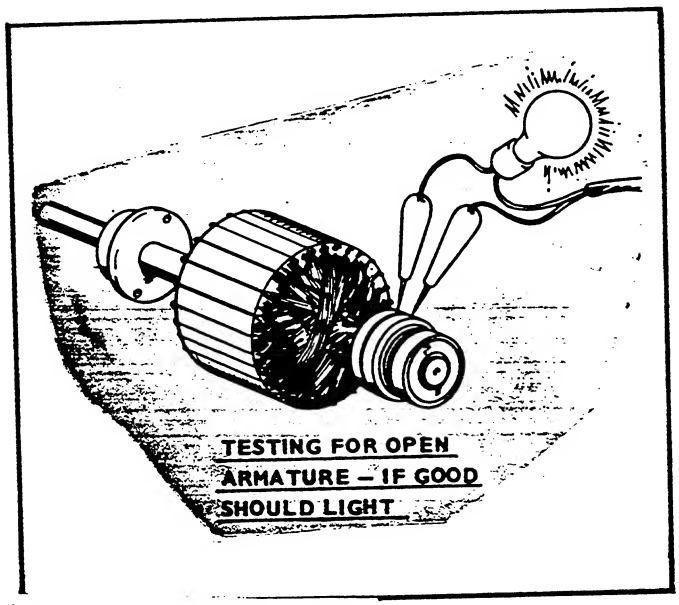


FIG.36 - ARMATURE OPEN TEST

Armature Ground Test

To test the armature for a grounded condition, lift or remove the brushes so that none contact collector rings. Use a continuity type test lamp set.

Place one test prod on one of the collector rings and the other test prod on the armature shaft. If the test lamp glows, the AC winding or a collector ring is grounded. Replace a grounded armature with a new one.

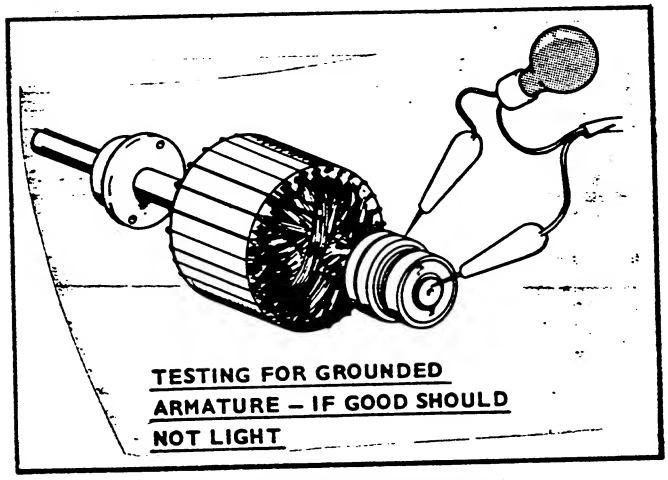


FIG.37 - ARMATURE GROUND TEST

Armature Short Circuit Test

To test for a short circuit, place the armature in a growler. With the growler current on, hold a steel strip about 1/2" above the armature laminations. Pass the strip back and forth over the laminations. Cover as much of the lamination area as possible. If the strip is magnetically attached to the armature at any point, a short circuit is indicated. After testing in one position, rotate the armature slightly in the growler and repeat the test. Continue until a complete revolution of the armature in the growler has been made. Replace a short circuited armature with a new one.

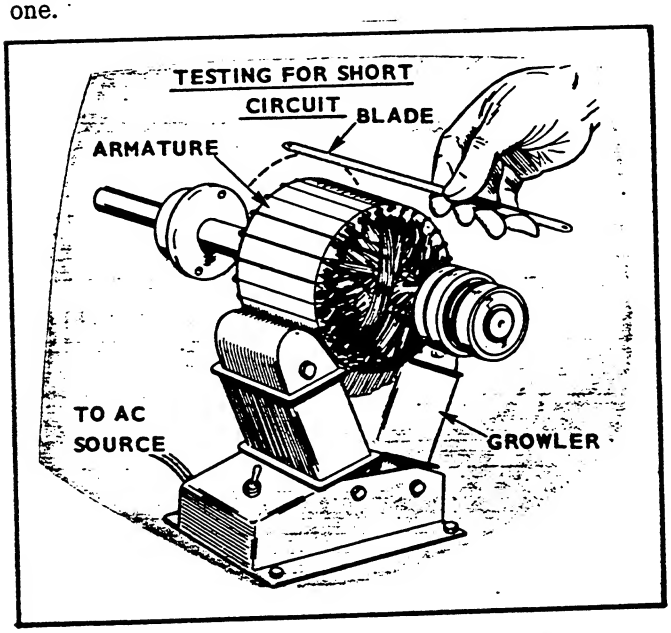


FIG.38 - ARMATURE SHORT CIRCUIT TEST

Testing Field Windings

Use a test lamp set for all tests except a short circuit. The field coils of all AC plants are saturated shunt wound, the remote start plants having a series field winding in addition for cranking and battery charging purposes. When testing a field coil assembly, disconnect all of its external leads from their terminals. Tag and mark each lead to assure proper connections when reassembling.

Testing Field Winding for Grounds

To test a coil assembly for a ground, disconnect its external leads and touch one test prod to the terminal of one of its leads and the other test prod to the generator frame. If the lamp lights, the coil assembly being tested is grounded. The ground may be in a coil, coil connection, or coil lead. Repair or replace as needed.

Testing Field Windings for Open Circuit

To test a coil assembly for an open circuit, disconnect its external leads and touch one test prod to the terminal of one coil winding lead, and the other test prod to the other lead (or leads) of that coil winding. If the lamp does not light, the winding being tested is open. If the fault lies in a connection between coils, or in a coil lead, the connection can be repaired. If it is inside the coil, replace the entire coil assembly with a new one.

Ball Bearing

If replacement of the armature ball bearing becomes necessary, pull the bearing from the shaft with a suitable bearing puller. Be careful not to damage the armature shaft because it must remain true to serve as a turning center when refinishing the commutator or collector rings. Drive the bearing on to the shoulder on the shaft. Use a double-sealed pre-lubricated ball bearing.

Generator Assembly

Be sure the run-out at the collector ring end is not more than .012" (Fig. 40). Excessive run-out may be due to a nick or dirt on the taper of either the armature or crankshaft. Remove any foreign material, install the armature, than correct excessive run-out by striking the high side of the shaft near the ball bearing. Never strike the collector rings.

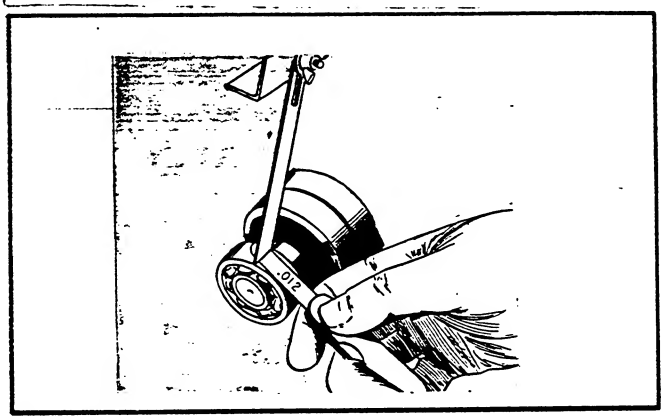


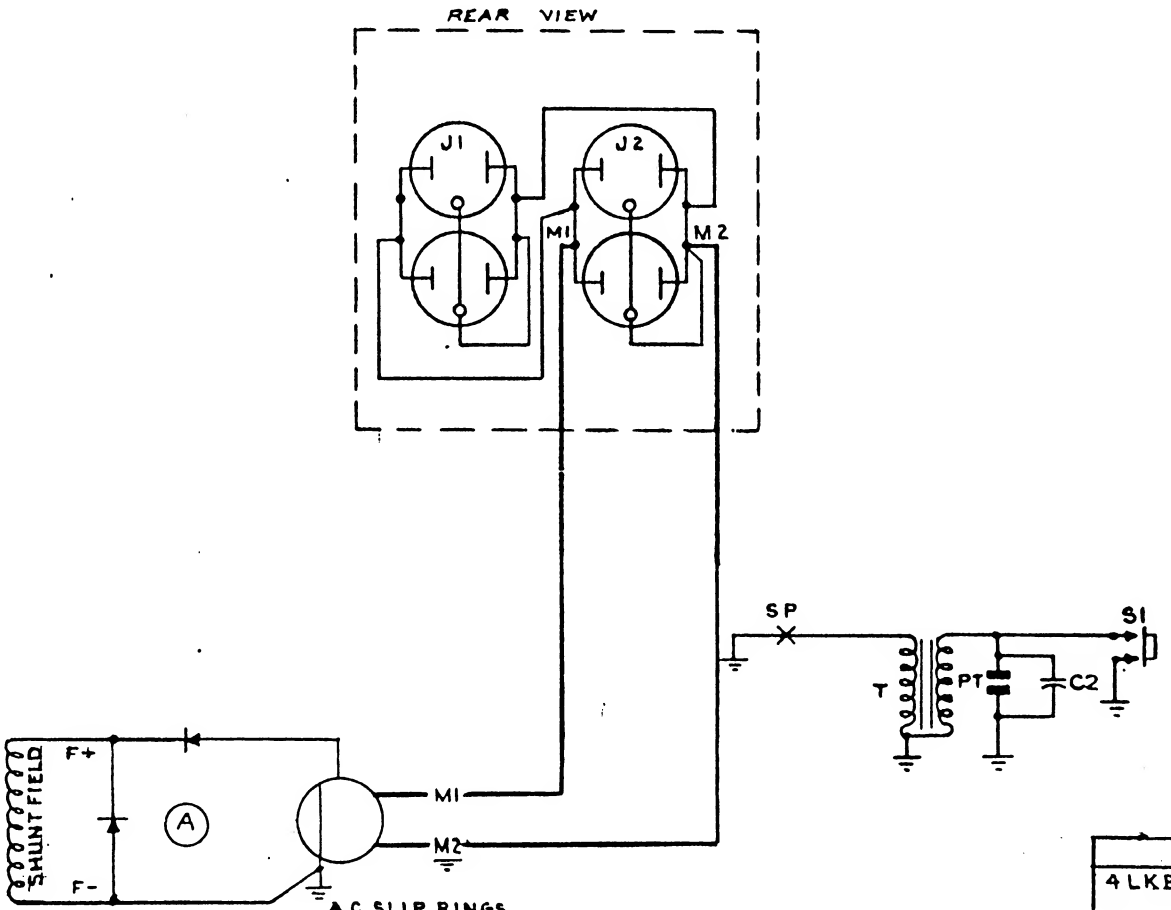
FIG.39 - GENERATOR RUN-OUT

The frame will mount only in the correct side upward. If the brush rig has been removed, it must be installed in its original position. Avoid accidentally damaging brushes during assembly. Check for good brush contact and for good spring tension.

Control Box Equipment

Always disconnect the battery from the plant whenever servicing any control box equipment. Keep all connections tight and clean, and inspect leads occasionally for worn insullation. If any of the control box equipment does not function properly, replace the defective part with a corresponding new unit. It is seldom practicable to repair relays, switches, etc.

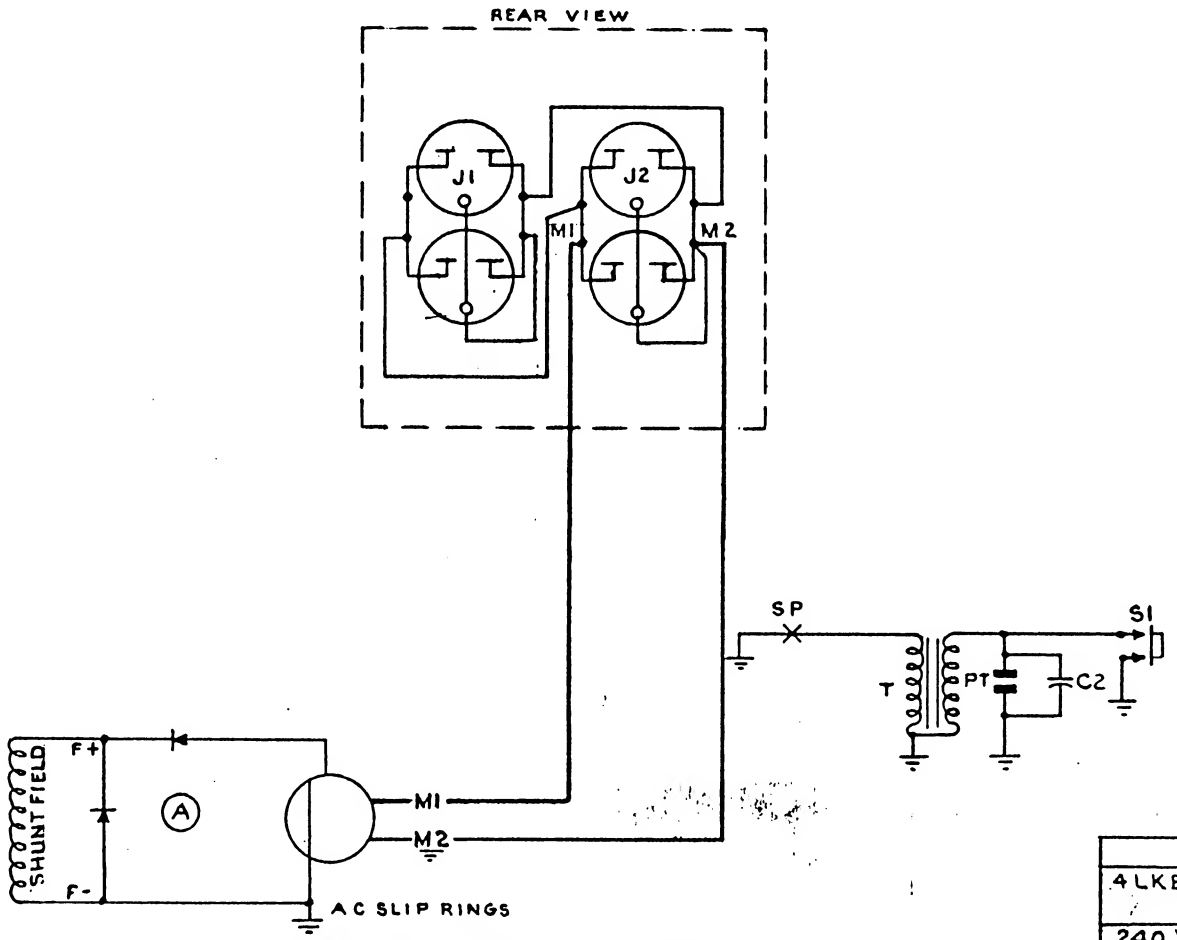
601B147



M1 HAS .1 MFD. CAPACITOR TO GROUND.

MODEL	Onan DIVISION OF STUDEBAKER CORPORATION Minneapolis, Minnesota
4LKB-1M/1A	DATE 1-31-66 · DR. CKH · ENGR. RMB · CKD. WJB · SC.
120 VOLT 1PH. 2WIRE 60CY.	NAME ENGINE GENERATOR WIRING DIAGRAM
	MODEL · DWG. NO. 601B147

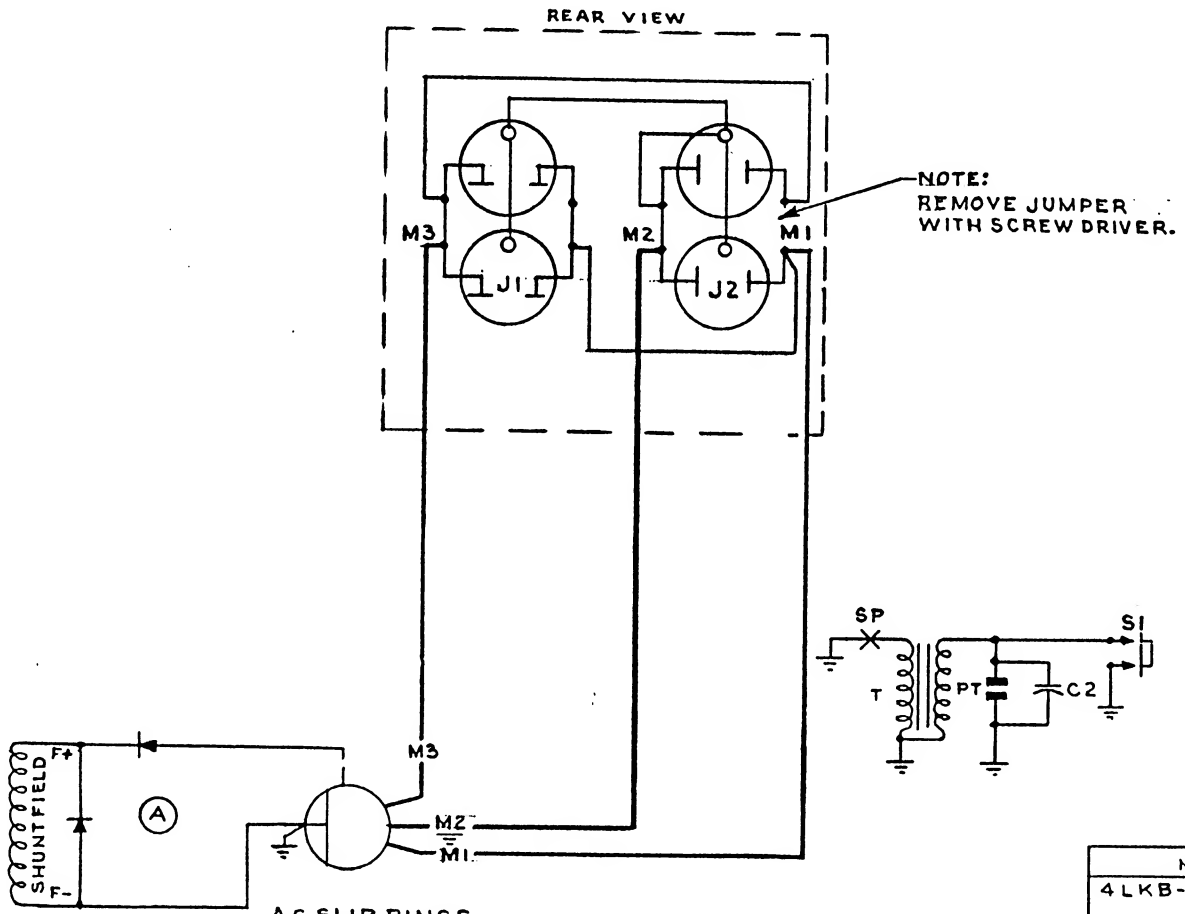
601B148



M1 HAS .1 MFD. CAPACITOR TO GROUND.

MODEL	Onan DIVISION OF STUDEBAKER CORPORATION Minneapolis, Minnesota
4LKB-2M/1A	DATE 1-31-66 DR. CKH ENGR. RmB CKR. WJB SC. ~
240 VOLT 1PH. 2WIRE 60CY.	NAME ENGINE GENERATOR WIRING DIAGRAM
	MODEL DWG. NO. 601B148

601 B149



AC SLIP RINGS

ALL UNGROUNDED AC LEADS HAVE .1 MFD. CAPACITORS TO GROUND.

MODEL	4LKB-3M/1A
	120-240 VOLT 1PH. 3 WIRE 60CY.

Onan DIVISION OF STUDEBAKER CORPORATION Minneapolis, Minnesota

DATE	DR.	ENGR.	CKR.	SC.
1-31-66	CKH	KMB	WJB	~

NAME: ENGINE GENERATOR WIRING DIAGRAM

MODEL:

DWG. NO. 601 B149